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TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

ELECTRIC FANS ON SHIPBOARD.

One of our English exchanges announces that electric fans will be introduced in the sick bays of his Britannic Majesty's ships, thus bringing comfort and fresh air to the sick seamen.

Popularity of the Electric Fan.

Few inventions of recent times have done more to relieve suffering humanity or have found such universal favor as the electric fan, and its popularity is ever on the increase. We have no doubt that so much benefit and comfort will result from its use in the sick bays of these vessels that it will soon be in use throughout those vessels which spend much of their time in warm climates. Thus is another laurel added to the already lavishly decorated electric fan.

ENGINEERING LABORATORIES.

Engineering practice is founded upon a thorough grounding in principles and an accurate knowledge of materials. The former can nowhere be better secured than at our excellent technical schools; but until recent years practically all engineering data were supplied by practising engineers and engineering companies. Naturally, data furnished by one man could not be complete, but the accumulation of the experience of many men over many years furnished fairly satisfactory figures upon which to base calculations.

Need for Testing Laboratories.

However, it was recognized years ago that this method of securing data was not efficient, and the process of learning by trial and failure was slow and costly. It was also recognized that a shop devoted to the testing of materials and to a thorough study of each and every characteristic of the substance under test, would furnish quickly, and at less cost, more complete information than years of practice had brought together. Laboratories had done much to advance the knowledge of science, and it was but natural that engineers should turn to laboratory methods for supplying the needed information.

Tests of Material Valuable.

The value of making tests to check work had long been recognized by factory managers, and many establishments had testing machines suited to their needs located in some corner of the shop, but the entire equipment could hardly be designated as elaborate. As the business of the company developed, and it became necessary to expand into other lines of work, in many of which certain tests must be made, the desirability of bringing together these separate testing departments under the control of one man soon became evident, and from this small beginning has grown the engineering laboratory, which to-day forms one of the most important departments of large manufacturing establishments.

Work of Testing Laboratory Expanded.

But the duties of the laboratory did not stop with the mere checking of work and materials. As new information was needed, it seemed but natural to call upon the testing laboratory to secure it. Thus, the laboratory found a new class of work thrust upon it. Researches must be conducted into new fields, new methods must be devised for attacking new problems, in order that engineering practice might advance along correct paths. So the testing departments developed into great engineering laboratories, which are pointed to with pride. The manufacturing companies can justly claim that to-day the great burden of engineering research rests on them.

Engineering Laboratories for Technical Schools.

But another need was soon felt. A correct use of materials necessitates not only accurate data, but an understanding of how a material should be tested. The engineering student must be taught methods of testing materials, as well as what they will do. An engineering school should have an engineering laboratory, and this need has resulted in the equipment of many fine laboratories in connection with technical schools. These were not always secured without difficulty, but the demand has been persistent and, in general, successful. These laboratories have already accomplished a great deal in the training of men, but, unfortunately, one important use of them has been neglected.

Relief Needed for Technical School Laboratories.

A finely equipped laboratory could carry on important researches and furnish information of inestimable value, but for the fact that, in general, the instructors are so tied down with teaching

and clerical work that they find little or no time for original research. Engineering schools have done much for the engineering professions, and it would be but just if practising engineers would use their influence in such a way that the greatest good might result from these laboratories. One of our large manufacturing establishments recently appropriated $50,000 for equipment for its research laboratory and evidently considers it a good investment. Yet there are a number of laboratories connected with technical schools already thoroughly equipped, but which, from conditions beyond the control of those in responsible charge, contribute little to engineering knowledge. Would not the interests of the community be best served and the fullest returns secured if the trained men in charge of these laboratories were given time to make good use of the equipment under their care?

THE GROWTH OF THE MOTOR DRIVE.

The advantages of the motor drive have been discussed so frequently of late that one is apt to form a false opinion of the extent to which this method has been employed. In an interesting article, entitled "The Use of the Small Electric Motor," in the current issue of the *Engineering Magazine,* the author, Mr. Frederick M. Kimball, states that probably less than seven per cent of the power distributed for manufacturing purposes in the United States is distributed electrically.

Number and Output of Motors in Use.

Doubtless this is less than many of us have been led to believe; but, looking at the matter in another way, the showing made by the electric motor assumes a different aspect. The same writer states that, excluding railway motors, automobiles, fans and elevators, there are sixty thousand motors in this country in daily operation. These motors represent an investment of $12,000,000 and are supplying something like one million horse-power. This is certainly a creditable showing for this comparatively recent method of distributing power.

Wide Field for Motors.

However, as these figures represent but seven per cent of the power used for manufacturing purposes, it is evident that there is a vast field for the further application of the electric motor, and no doubt the recent papers and discussions, presenting the advantages of this method of driving, will have very beneficial results in this direction.

Advantages for Electric Driving.

The points made in favor of the electric motor by Mr. Kimball in his brief summary are surely enough to ensure a rapidly increasing application—"The final results of all these desirable features of electric driving and the use of motors are increased output, lower cost, higher quality of product, and larger profits."

THE ELECTRODYNAMIC CONDENSER.

In an interesting article, which we reprint in this issue from the London *Electrician,* Mr. James Swinburne describes the electrodynamic condenser. This consists of an ironclad electromagnet having an annular air-gap. Within this air-gap a coil of wire is suspended so as to be free to vibrate in the strong magnetic field set up by an exciting coil. The armature coil is held in position in the magnetic field by weak springs. Upon passing an alternating current through this coil, it is set vibrating in the field and, of course, sets up an electromotive force, the value of which at any instant is proportional to the rate of cutting the flux and since the field may be assumed to be practically uniform, to the velocity of the moving coil.

Action of the Coil.

Imagine this coil to be acted upon only by the force set up by the action of the magnetic field upon the current flowing throught it. Obviously, the coil will be set in motion and will accelerate as long as the current is flowing through it in one direction. Its velocity, and, hence, the electromotive force set up by its motion, will be maximum as the current passes through zero. The current and electromotive force will therefore be in quadrature and the machine will behave as a condenser.

A Practical Condenser.

Mr. Swinburne works out a practical machine of this kind. The armature coil weighs 1,410 grammes and is twenty-five centimetres in diameter. This coil vibrates through a path eight centimetres in length. With an induction of 16,000 lines per square centimetre and a frequency of fifty cycles per second, this machine develops an effective electromotive force of 222 volts, the effective current being thirty-nine amperes. The apparent power is thus 8,600 watts. This corresponds to a static condenser having a capacity of about 700 microfarads. The loss is given as about two per cent.

Advantages of This Type of Condenser.

This would seem to be a very practical type of condenser. Compared with a static condenser of the same capacity it would be cheap and occupy much less space. The efficiency is high and the electromagnetic condenser would probably compare favorably with the static condenser in this respect. The type here described, however, is not suitable for low frequency, but M. Leblanc has shown that in these cases a dynamo or motor may be used. The principle is the same as the armature swings backward and forward.

Uses for the Electromagnetic Condenser.

Static condensers of sufficient capacity to be of practical use are bulky and expensive, and it would seem that the machine proposed by Mr. Swinburne might find a variety of applications. At present over-excited synchronous motors are used in some cases, as they act as condensers if run in this way. They have been used to balance the inductance of induction motors and to assist in regulation at generating stations which are supplying an inductive load. Under these conditions the capacity of the synchronous motor for other work is reduced, as the heating of its armature depends upon the current flowing, and not upon the mechanical work the motor may be doing. It would seem that in this case the electromagnetic condenser would find a useful application. It might also be used in starting single-phase induction motors, and for supplying the wattless current for induction motors and the exciting current for induction generators. There is little need for an apparatus of this kind in transmission work, as in general the capacity of the line is, if anything, too great.

THE KUMASCOPE.

A series of interesting and valuable lectures on wireless telegraphy has been delivered recently by Professor J. A. Fleming before the Society of Arts in London. Dr. Fleming is the adviser of the Marconi Company, and is familiar with the practical problems as well as the theory of this method of transmitting intelligence. These lectures give the most comprehensive exposition of the subject that has yet appeared.

The Kumascope.

In one of these lectures Dr. Fleming called attention to the need of a general term to designate the various instruments which are now employed to detect electrical waves. Each inventor of a new instrument uses his right in selecting a distinctive name, but as yet there is no satisfactory general term to designate the sensitive instrument, of whatever type, which is used to detect electrical waves. Dr. Fleming therefore suggests the word "kumascope," a word made up from two Greek words signifying a "wave spy." The term is fairly satisfactory, but has been criticised by the *Electrical Times*, of London, which paper suggests "cymatoscope" as being more philologically correct, though this paper is not entirely satisfied with its own effort. Not to venture into a discussion of the correctness of the two terms, that suggested by Dr. Fleming is the shorter.

A Friendly Criticism.

The New York *Tribune* is always ready with timely and helpful criticism, and makes the following comment upon the new term:

A timely and welcome recommendation was made in one of Professor Fleming's lectures. He proposes the adoption of "kumascope" as a name for the receiving instrument in wireless telegraphy. One advantage of the word is that it is more comprehensive and general than "coherer," "responder," "magnetic detector" and the specific titles given to other devices forming the same function. It is also short, euphonious, constructed on correct etymological principles, and appropriate. The first half of the word is a Greek noun, meaning "a wave." It would be hard to find another which would meet all the requirements of the situation so admirably. Another word is suggested by this one, although Professor Fleming does not appear to have thought of it. There is a crying need for a suitable term to designate a message sent by wireless telegraphy. Why not call it a "kumagram?" This, too, is short, sounds well, has a legitimate derivation and is free from one objection to "Marconigram" or "conigram." Great as is Marconi, he is not the only contributor to the new system of communication. If any one man's name should be incorporated in the word for which there is now a pressing demand, that man is Hertz. "Hertzgram" is not so bad; but "kumagram" is better.

"Kumagram" is short enough, and, though it might be more euphonious, electrical engineers are not wont to criticise their terms on that account. We would be glad to hear from the philologists, as they might be able to suggest an improvement and it does no harm to have their sanction to the use of a word.

TRANSFORMERS IN TRANSMISSION SYSTEMS—Concluded.

BY ALTON D. ADAMS.

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The circulation of air or water through a transformer should never be forced to an extent that cools the transformer below the temperature of the air in the room where it is located, as this will cause the condensation of water on its parts.

In some cases it is desirable that means for the regulation of transformer voltages through a range of ten per cent or more each way from the normal be provided. This result is reached by the connection of a number of sections at one end of the transformer winding to a terminal board, where they may be cut in or out of action at will. Regulation is usually desired, if at all, in a secondary winding of comparatively low voltage, and the regulating sections generally form a part of such winding, but these sections may be located in the primary winding.

In order to keep the number of transformers smaller and the capacity of each larger than it would otherwise be, it is practicable to divide the low-voltage secondary winding of each transformer into two or more parts that have no electrical connection with each other. These different parts of the winding may then be connected to distinct distribution lines or other services. An example of this sort exists in the Hooksett substation of the Manchester, N. H., transmission system. Three-phase current at about 11,000 volts enters the primary windings of three transformers at this substation. Each of these transformers has a single primary, but two distinct secondary windings. Three of these secondaries, one on each transformer, are connected together and feed a rotary converter at about 380 volts, three-phase. The other three secondary windings are connected in like manner to a second rotary converter. Each of these transformers is rated at 250 kilowatts, and each rotary is rated at 300 kilowatts, so that the transformer capacity amounts to 750 kilowatts and that of the converters to 600 kilowatts, giving a desirable margin of transformer capacity for railway service. With the ordinary method of connection and windings, six transformers of 125 kilowatts each would have been required in this substation.

High voltage for transmission lines may be obtained by the combination of two or more transformers with their secondary coils in series. This method was followed in some of the early transmissions, as in that at 10,000 volts to San Bernardino and Pomona, begun in 1891, where twenty transformers, giving 500 volts each, were used with their high-voltage coils in series. Some disadvantages of such an arrangement are its high cost per unit of transformer capacity and its low efficiency.

In a single-phase system the maximum line pressure must be developed or received in the coils of each transformer, unless two or more are connected in series. This is also true as to either phase of a two-phase system with independent circuits. In three-phase circuits the coils of a transformer connected between either two wires obviously operates at the full line pressure. The same result is reached when the three transformers of a group are joined to the line in mesh or Δ-fashion. If the three transformers of a group are joined in star or Y-fashion, the coils of each transformer are subject to fifty-eight per cent of the voltage between any two wires of the three-phase line to which the group is connected. It is no longer the practice to connect two or more transformers in series either between two wires of a two-phase or between two wires of a three-phase circuit, because it is cheaper and more efficient to use a single transformer in each of these positions. Where very high voltage must be developed or received with a three-phase system, the star or Y-connection of each group of three transformers has the advantage of a lower strain on

the insulation of each transformer than that with the mesh or △-grouping. Thus if the △-grouping is used, the line pressure equals that of each transformer coil, but if the Y-grouping is used the line voltage is 1.73 times that of each transformer coil.

At the Colgate power-house, the 700-kilowatt transformers are designed for a maximum pressure of 60,000 volts on the three-phase line when Y-connected, so that the corresponding voltage in their secondary coils is 34,675. The primary coils of these same transformers are connected in mesh or △-form and each coil operates at 2,300 volts, the generator pressure.

Transformers are in some cases provided with several sets of connections to their coils so that they may be operated at widely different pressures. Thus, in the Colgate plant, each transformer has taps brought out from its secondary coils so that it can be operated at either 23,175, 28,925, or 34,675 with 2,300 volts at its primary coil. Corresponding to the three voltages named in each primary coil are voltages of 40,000, 50,000, and 60,000 on a three-phase line connected with three of these transformers in Y-fashion.

The mesh or △-connection is used between the coils of transformers on some transmission lines of very high voltage. The 950-kilowatt transformers in the system between Cañon Ferry and Butte illustrate this practice, being connected △-fashion to the 50,000-volt line.

When transformers that will operate at the desired line voltage on △-connection can be obtained at slight advance over the cost of transformers requiring Y-connections, it is often better practice to select the former, because this will enable an increase of seventy-three per cent in the voltage of transmission to be made at any future time by simply changing to Y-connections. Such an increase of voltage may become desirable because of growing loads or extension of transmission lines.

An example of this sort came up some time ago in connection with the transmission between Ogden and Salt Lake City, which was operating at 16,000 volts, three-phase, with the high-pressure coils of transformers connected in △-form. By changing to Y-connections the line voltage was raised seventy-three per cent without increasing the strain on transformer insulation.

In some cases it is desirable to change alternating current from two-phase to three-phase, or *vice versa,* for purposes of transmission or distribution, and this can readily be done by means of static transformers. One method often employed to effect this result includes the use of two transformers connected to opposite phases of the two-phase circuit. The three-phase coil of one of these transformers should be designed for the desired three-phase voltage, and should have a tap brought out from its central point. The three-phase coil of the other transformer should be designed for eighty-seven per cent of the desired three-phase voltage. One end of the coil designed for eighty-seven per cent of the three-phase voltage should be connected to the centre top of the three-phase coil in the other transformer. The other end of the eighty-seven per cent coil goes to one wire of the three-phase circuit. The other two wires of this circuit should be connected, respectively, to the outside end of the coil that has the central tap. As a matter of illustration it may be required to transform 500-volt, two-phase current from generators, to 20,000-volt, three-phase current for transmission. Two transformers designed for 500 volts in their primary coils, are necessary for this work. One of these transformers should have a secondary coil designed for 20,000 volts, so that its ratio of transformation is 20,000 ÷ 500 or 40 to 1, and a tap should be brought out from the centre of this coil. The other transformer should have a secondary voltage of $0.87 \times 20{,}000 = 17{,}400$, so that its ratio of transformation is 34.8 to 1.

These two transformers, with the connections above indicated, will change the 500-volt, two-phase current to 20,000 volts, three-phase.

At one of the water-power stations supplying energy for use in Hartford, four transformers of 300-kilowatts each change 500-volt, two-phase current from the generators to 10,000-volt, three-phase, for the transmission line.

In the Niagara water-power station the generators deliver two-phase current at 2,200 volts, and 975-kilowatt transformers are connected in pairs to change the pressure to 22,000 volts, three-phase, for transmission to Buffalo.

A transformer is used in some cases to raise the voltage and compensate for the loss in a transmission line. For this purpose the secondary of a transformer giving the number of volts by which the line pressure is to be increased is connected in series with the line. The primary winding of this transformer may be supplied from the line boosted or from another source.

Transformers ranging in capacity from 100 to 1,000 kilowatts each, such as are commonly used for transmission work, have efficiencies of ninety-six to ninety-eight per cent at full loads, when of first-class construction. Efficiency increases slowly with transformer capacity within the limits named, and ninety-eight per cent can be fairly expected in only the larger sizes. In any given transformer the efficiency may be expected to fall a little, say one per cent between full load and half load, and another one per cent between half load and quarter load. These figures for efficiencies at partial loads vary somewhat with the design and make of transformers. In general, it may be said that step-up or step-down transformers will cost approximately $10 per kilowatt capacity, or about one-half of the like cost of low-voltage dynamos. If dynamos of voltage sufficiently high for the transmission line can be had at a figure below the combined cost of low-volt dynamos and raising transformers, it will usually pay to avoid the latter and develop the line voltage in the armature coils. This plan avoids the loss in one set of transformers.

TRANSFORMERS IN TRANSMISSION SYSTEMS.

Transmission System.	Transformers at Power Stations.		Transformers at Substations.		Generators at Power Stations.	
	Number	Kw. each.	Number.	Kw. each.	Number.	Kw each.
Cañon Ferry to Butte	12 6	325 950	*	*	....	....
			6	950	10	750
Apple River to St. Paul	..	....	6 4	300 200	....	....
					4	750
White River to Dales	6	500	3	375	2	500
Farmington River to Hartford	3	400			2	600
Ogden to Salt Lake	4	300	....	....	2	600
	†9	250	....	....	5	750
Colgate to Oakland	....	700	....	....	3 4	1125 2250
Presumpseat River to Portland	..	....	6 3	200 150	....	....
					4	500
Four Water Powers to Manchester	...	....	21	200	1 3 1 4 1	180 300 450 650 1200

* Other transformers at Helena substations.
† Part of energy distributed directly from generators.

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—XIV.

Notes on Progress in Europe and America.

BY JOHN B. C. KERSHAW.

Rapid Tests for Ammonium Chloride.

Though the primary battery as a source of electricity is now relegated to a comparatively unimportant and humble position, the aggregate number of primary cells in actual use for telephone and telegraph systems would probably astonish electricians—if such an aggregate could be obtained—and of such cells the old Leclanche zinc-carbon cell is undoubtedly still the most widely employed. The following rapid methods for testing the purity of ammonium chloride may therefore prove of interest to readers of these notes who have a large number of such primary cells under their charge, for ammonium chloride is a salt which is undoubtedly capable of easy sophistication, and sodium chloride, the usual adulterant, is unfortunately much cheaper and less suited to the maintenance of the efficiency of Leclanche cells.

The first method depends upon the depression of temperature due to heat absorption, which follows the solution of pure ammonium chloride, and, therefore, by operating with a weighed amount of the salt, and a definite volume of water, and noting the depression in temperature, a rough idea can be obtained of the purity of the salt. Using twenty-five grammes of salt, in 250 cubic centimetres of water, and performing the operation in a thick walled glass flask, the following variations in the depression of temperature indicate the successive stages of sophistication with sodium chloride:

	Temperature Depression. Degree C.
Pure NH_4Cl	6.00
NH_4Cl with 5% NaCl	5.75
NH_4Cl with 10% NaCl	5.50
NH_4Cl with 15% NaCl	5.25
NH_4Cl with 20% NaCl	5.00
Pure NaCl	1.50

The temperature should be taken with a delicate thermometer within one minute of the solution of the salt, which is accelerated by vigorous shaking of the salt and water.

The second method is based upon the increase of Sp.Gr. which is obtained when sodium chloride is present as an impurity. It is essential when carrying out this test, that the observation should be made at the temperature of fifteen degrees centigrade, and therefore after solution of the salt, an interval of time must be allowed to elapse for the flask and its contents to attain the laboratory temperature. With seventy-five grammes of salt dissolved in 250 cubic centimetres of water (the solution obtained in the previous test is too dilute) the following figures represent the variations in Sp.Gr. with increasing amounts of NaCl:

	Sp. Gr.
NH_4Cl pure	1.071
NH_4Cl with 5% NaCl	1.075
NH_4Cl with 10% NaCl	1.079
NH_4Cl with 15% NaCl	1.083
NH_4Cl with 20% NaCl	1.087

Further details of these rapid methods can be obtained from the original article by Rosset in the *Centralblatt f. Accumulatoren und Elementenkunde* of February 1, 1903.

Conclusion of First Series of Notes.

In concluding this first series of "Notes on Industrial Electrochemistry and Electrometallurgy," the writer desires to draw attention to the fact that attention has been purposely confined to the practical side of the subject, and that patent literature has been studied only in so far as it may be considered to have industrial value.

It is no doubt true that every month new patents are being taken out in Europe and America for electrochemical processes and apparatus which will at some future date become of industrial importance. But until such processes have been subjected to experimental trial it is impossible to say whether they are likely to form the basis of successful branch industries. Without any risk of exaggeration, it is safe to assert that not one in twenty of the electrochemical and electrometallurgical patents actually applied for and granted in Europe or America has been in the past successfully exploited and developed. For this reason alone, it is wise to allow time to perform its usual weeding work before dealing with patent literature in these new branches of applied science. A second reason for confining the scope of these notes chiefly to the practical and industrial side of the subject is that several of the contemporaries of the ELECTRICAL REVIEW are devoting increasing amounts of space to the abstraction and analysis of electrochemical patent literature, and that for reasons well known to those who attempt it, the collection and examination of "facts" relative to the progress of the new industries are less fully provided for. The writer, therefore, feels that he is filling a useful rôle in acting as chronicler and critic of facts relating to the industrial progress in electrochemistry and electrometallurgy. He will at all times be pleased to receive from those working at the problems of applied electrochemistry, for use in these columns, details of new processes and apparatus which are receiving, or have received, experimental trial upon an industrial scale. The following index will no doubt prove useful for reference to those interested in the development of the new industries:

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Swedish Brake for Electric Motors.

Mr. R. S. S. Bergh, consul at Gothenburg, Sweden, reports that Mr. Arthur Hultquist, assistant engineer in the workshops of the electrical street railways of this city, has recently constructed a brake for electric motors which consists of a small automatic reversing switch which is fastened near the motor. On every machine is a pendant handle bearing the words "emergency brake" in red letters. If a workman should happen to be caught in the machinery or any other accident should occur, the machinery can be quickly stopped by pulling the handle, which sets the brake in action. It is claimed that the machine can be stopped in this way within one-half or one-fourth rotation. It is expected that this brake will be found very useful in every establishment where electric motors are in use.

The Question Box at the National Electric Light Association Convention.

A preliminary list of 125 questions has been tabulated by Mr. Hartman, editor of the question box for the twenty-sixth convention of the National Electric Light Association. This list has been made up from questions already received from members. New questions are coming in daily, and it is estimated that this feature of the programme will prove a very important part of the meeting. Many questions relate to subjects which have not already been brought up for discussion, and will no doubt bring out valuable information.

MODEL SHOWING DISTRIBUTION OF ELECTROMOTIVE FORCE AND CURRENT ALONG A SINGLE-PHASE ALTERNATING-CURRENT TRANSMISSION LINE.[1]

BY W. S. FRANKLIN.

A helical line drawn on the surface of a transparent cylinder and set rotating about its axis would appear to an observer looking at it from one side as a wave line traveling along the axis. The direction of travel of this wave line would be one way or the other, according as the helix is right or left-handed.

A rotating right-handed helix would represent the electromotive-force waves (or the current waves) traveling outward from a generating station along a transmission line having inductance and capacity, but having neither resistance nor leakage.

A left-handed helix rotating in the same direction about the same axis would represent the electromotive-force waves (or the current waves) reflected back from the receiver. A compound helix of which the radius vector at each point along the axis is the sum of the radii vectors of the two simple helices would, if set rotating, represent the actual distribution of electromotive force (or current) along the transmission line.

The effect of line resistance and line leakage is to cause the waves of electromotive force and current to diminish in amplitude as they travel along the line.

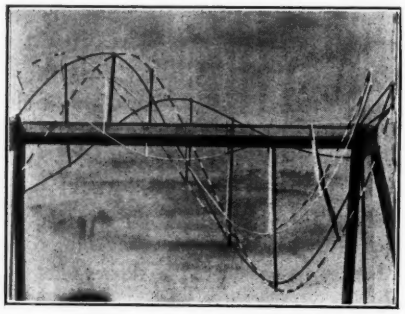
Imagine a helix-like line drawn about an axis, the radius vector of this helix-like line at a point along the axis being proportional ϵ^{-x} where ϵ is the Napierian base and x is the distance measured along the axis from one end. If this helix-like line is set rotating about the axis, it will appear to an observer looking at it from one side as a wave line traveling along the axis and diminishing in amplitude as it travels along.

A rotating right-handed helix-like line of the kind just specified would represent the electromotive-force waves (or the current waves) traveling outward from a generating station along a transmission line having inductance, capacity, resistance and leakage.

A left-handed helix-like line rotating in the same direction about the same axis would represent the electromotive-force waves (or the current waves) which are reflected back from the receiver.

A compound helix-like line of which the radius vector at each point along the axis is the vector sum of the radii vectors of the two single helix-like lines, would, if set rotating, represent the actual distribution of electromotive force (or current) along the transmission line.

The model which is herewith exhibited contains: (A), two simple and one compound helix-like lines, which represent outgoing, reflected, and resultant electromotive-force waves respectively; and (B), two simple and one compound helix-like lines which represent outgoing, reflected, and resultant current waves respectively.



MODEL FOR A SINGLE-PHASE ALTERNATING-CURRENT TRANSMISSION LINE.

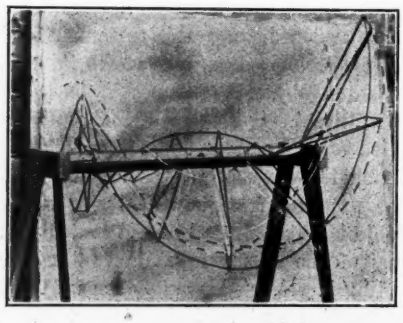
This model was calculated and constructed by Messrs. J. H. Flory and C. W. Startsman, as a graduating thesis in electrical engineering, at Lehigh University in 1901.

The calculations were based upon the following data:

Length of line, 200 miles.

Resistance of line one ohm per mile.

Reactance of line due to inductance four ohms per mile.



PERSPECTIVE VIEW OF ALTERNATING-CURRENT MODEL.

Leakage conductance of line, 0.00002 ohm per mile.

Capacity susceptance of line, 0.0002 ohm per mile.

Receiver is a condenser having a reactance value of 100 ohms.

The actual value of electromotive force (or current) is not essential to the interpretation of the model, but as a matter of fact the voltage at the terminals of the receiving circuit was taken to be 10,000 volts and the current, of course, 100 amperes.

[1] A paper read at the 174th meeting of the American Institute of Electrical Engineers, New York, March 27, 1903.

THE NEW TELEPHONE AND TELEGRAPH BUREAU AT THE WHITE HOUSE.

BY WALDON FAWCETT.

The telephone and telegraph headquarters, or, as it is officially designated, the Telegraph and Cipher Bureau, is easily one of the most important adjuncts of the new White House offices in Washington. The quarters at present occupied by what has been so aptly termed the President's "intelligence office" are not as commodious as those apportioned to this division of the Presidential establishment when the Executive Offices occupied half of the second floor of the White House proper, but the equipment of the new telephone and telegraph bureau surpasses in many respects the appointments previously available.

It is significant that the growth and development of the national government may be clearly traced by means of the expansion of the functions of this office. During the Civil War the President was dependent upon messenger service between the White House and the War Department, a block away, the government wires converging at the last-mentioned building, and there being at the White House no direct communicative facilities. Later the exigencies of governmental administration resulted in wires being run direct to the White House, and on more than one occasion during the great railroad strike in Chicago President Cleveland sat at one end of the telegrapher's table in the White House, while the general commanding the army sat opposite, and these men actually conferred by wire with the army officers in command in the western metropolis.

It was, however, during the administration of the late President McKinley that the Telegraph and Cipher Bureau attained by rapid development a degree of perfection that has made the unique institution the marvel of every foreign governmental official who has visited the White House in recent years. Indeed, M. Cambon, formerly French ambassador at Washington, went so far as to attribute much of the success of the United States in the Spanish-American War to the facilities for quick communication afforded by this splendidly equipped department.

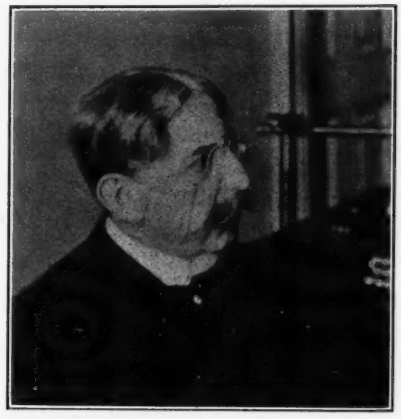
Sixty-five wires converge at the Telegraph and Cipher Bureau. The arrangement is such that it is possible to secure a direct wire, either telegraph or telephone, to any city at any time, reserving it for governmental business as long as desired. There is provided a double-wire

for direct communication with the President whenever he is absent from the city and another double wire affords an exclusive line for the transmission of confidential cipher business between the President's office and the cable offices in New York. As a rule, cablegrams are despatched through the New York offices of the cable companies, but there have been instances in which the White House operators worked direct with the terminal offices of the cables at Sydney, Cape Breton.

The private telephone system, which has its headquarters at the White House office building, consists of three separate trunk lines, with seventeen miles of exterior lines, giving direct wires to the nine executive departments of the government, the Government Printing Office, the Library of Congress and other branches of the government. There are, moreover, a number of separate telephone stations at the White House, located in the kitchens, the private apartments, the stables and elsewhere. The entire system is controlled by a switchboard in the central exchange of the bureau. The headquarters of the police and fire departments are, of course, reached by means of the wires of the Washington telephone system, but private wires connect the White House with the Senate and House of Representatives, so that the President is enabled to at any time communicate confidential messages to members of either house of Congress.

To ensure secrecy, the system of wires which connects the President's office with the desks of the various members of the Cabinet at their respective departments is automatic in its action. Then, too, not only is the White House telephone exchange a central office exclusively under government control, but all operators are government employés, and practically no confidential business passes through the city central office. However, the telephone system, although under government control, was installed by a private corporation which merely leases the equipment to the government.

Method and concentration are the keynotes of the administration of the telephone and telegraph headquarters at the Presidential mansion. At times unusual expedients have been resorted to. For instance, on occasions operators receiving long telephonic messages have repeated them word by word to graphophones to be transmitted to the President at his leisure and in a few instances graphaphones of carefully gauged speed have been used to record long messages clicked off by the telegraph instruments. Resort has been made to this method only when the office was rushed with work, and when the operators welcomed the means which enabled them to record the incoming messages in such manner that they could be transcribed when opportunity offered.



COL. BENJAMIN F. MONTGOMERY, IN CHARGE OF GOVERNMENT TELEPHONE AND TELEGRAPH BUREAU.

The system employed has enabled the performance by half a dozen White House telegraphers of work that under less favorable circumstances would require the combined efforts of fifteen or twenty men. The White House telephone and telegraph headquarters is never closed—indeed, it is the only telegraph office in the government service which is in operation continuously—and this makes it necessary for the operators to work in three "shifts" of eight hours each. The Telegraph and Cipher Bureau is under the direction of Colonel Benjamin F. Montgomery, an officer of the Signal Corps, United States Army, who is specially detailed for this duty and who has served as "intelligence officer" at the White House for so many years that he is justly regarded as one of the veterans of the staff of the Executive Offices.

All of the telegraphers at the White House are what are known as "code men"—that is, capable of handling messages which are in cipher. Telegraphic messages are received in ten different codes. The State Department has three codes, for use chiefly in confidential communication with American representatives abroad, and the War and Navy departments each has three codes. With all of these the White House operators must be familiar, since many messages prepared by the secretaries of State, War and Navy are sent to the White House for Presidential approval, and, when this sanction is obtained, are despatched over the White House wires. In addition to the nine codes enumerated, the President has a private code in which messages are transmitted to and from the Chief Executive when he is touring the country or absent from Washington for any other reason. All codes are subject to change at any time.

The volume of business transacted by this telegraphic and telephonic clearing-house is well nigh incomprehensible. During the Spanish-American War the bureau handled nearly half a million tele-

TELEPHONE AND TELEGRAPH BUREAU, WASHINGTON, D. C.

grams, fully three-fourths of which were of a confidential nature. As evidencing the resourcefulness of the bureau it may be cited that within fifteen minutes of the time the late President McKinley was shot at Buffalo, the Signal officer at the White House had secured two exclusive wires to Buffalo—one a telegraph wire and the other a long-distance telephone circuit. During the last illness of the late President more than five thousand messages passed between the White House and the Milburn residence at Buffalo.

The bookkeeping connected with the administration of the telephone and telegraph establishment is no inconsiderable task. The messages originating in the various departments which are sent out over the White House wires must be charged to their respective sources, and in the case of the White House messages a separate account must be kept of the personal messages of the President and members of his family as distinguished from the official communications. Many of the important wire communications from the White House are repeated in order to ensure accuracy.

Presidents and high governmental officials have frequently, in cases of emergency, made the Telegraph and Cipher Bureau their temporary offices. Thus during the exciting days of the Spanish-American War, the President, the secretaries of War and the Navy sat for hours at the elbows of the telegraphers, directing in person the military operations thousands of miles distant and so perfect were the arrangements that during the advance on Santiago the President was enabled to communicate from Washington in less than twenty minutes with the officers on the firing line. When the President is absent from the capital and some members of the Cabinet are in Washington they almost invariably go to the bureau to communicate with him and frequently "long-distance Cabinet meetings" have been held in this manner. The President also goes to the bureau when he presses a button which sets in motion the wheels of an exposition. President Roosevelt, who declines to have a telephone in his private office, wishing to avoid the annoyances caused by the ringing of the bell at inopportune moments, necessarily makes frequent trips to the telephone booth in the bureau.

British Institution of Electrical Engineers.

The offices and library of the British Institution of Electrical Engineers have been moved to 92 Victoria street, London, to which address all communications should be sent.

DISTRIBUTION LOSSES IN ELECTRIC SUPPLY SYSTEMS.[1]

BY A. D. CONSTABLE AND E. FAWSSETT.

Few central station engineers expect to get paid for more than seventy-five per cent of the energy they generate. Of the remaining twenty-five per cent, about four-fifths is absolutely wasted; and, worse than that, it increases the waste which would otherwise take place. The other fifth is used in the station itself for lighting and other purposes, and can not be said to be actually wasted, although it is unproductive as regards revenue. It is worth while considering how this wasted twenty per cent is made up, and whether it is possible to reduce it in any way. The figures given in this paper refer to the Croydon electricity works.

SWITCHBOARD LOSSES.

Table I gives these initial losses in the case of three different sets of plant. The values were obtained by measurement, and may be taken as a very fair average of the usual existing conditions. Careful arrangement of the relative positions of the switchboard and generators and simple design of the switchboard will, to some extent, eliminate these losses. The minimum number of instruments should be installed, and these should be connected with as few joints as possible; ammeters should preferably be of the shunted type. Some switchboard erectors have a natural incapacity for screwing connections up tight, and some instrument makers are afraid of giving their customers too much metal. The authors have come across several cases of joints which have welded themselves together, of bus-bars running at or over 200 degrees Fahrenheit, and even of switch-gear working at a temperature of 150 degrees Fahrenheit at normal full load. One square foot of dull copper surface running at ten degrees Fahrenheit above the temperature of the air will continuously dissipate the heat produced by the absorption of about sixteen watts, or, if the excess temperature is fifty degrees Fahrenheit the watts will be about sixty. Main fuses should be avoided where possible, not only because they are objectionable in themselves, but to be of use they must run warm, and consequently waste energy.

In the station under consideration, which is of fairly modern design, with an output of only 1,250 kilowatts at the maximum, the total loss per annum in the switch-gear and connections alone (including those in the substation) amount to 10,000 units.

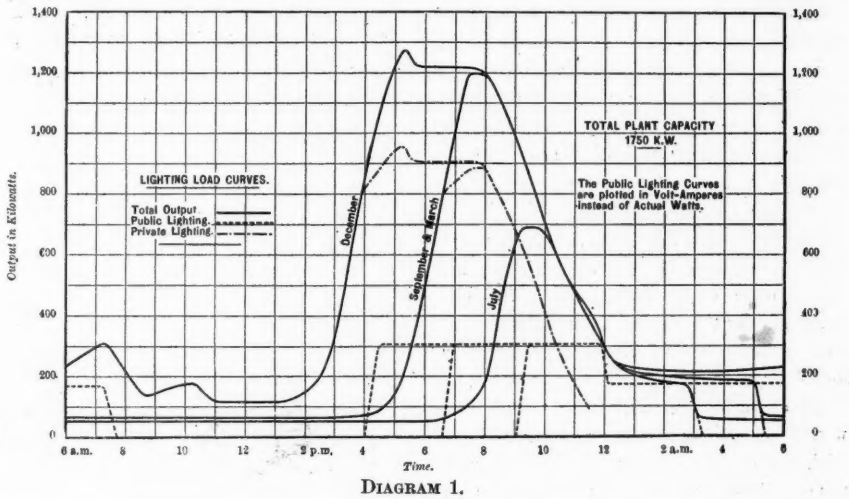


DIAGRAM 1.

TABLE I.

Losses up to and including main switchboard.

	System of Supply.	Maximum Output. Kilowatts.	Approximate Mean Loss in Per Cent of Output.
1	2,000 volts alternating current, one pole earthed..	1,250	0.43
2	500 volts direct current, tramways (A).....	500	0.42
3	500 volts direct current, tramways (B).....	400	0.30

Average loss in substation switch-gear (system 1) and connections, 0.10 per cent of output.

CABLE LOSSES.

Of all the losses in the system, the cable losses are the most important and those that can be least easily reduced. The larger part of this paper will, therefore, be devoted to their consideration. They may be split up into three components: (1) C^2R losses in the dielectric; (2) C^2R losses in the conductor; (3) losses due to what may be called dielectric hysteresis. The first may be shortly dismissed; it is, as stated above, generally very small, at any rate in the main feeders of a well laid out system.

The total insulation resistance between poles of this system of 2,000-volt feeders,

[1] Abstract of a paper read before the British Institution of Electrical Engineers, March 12, 1903.

comprising about twenty-five miles of concentric cable in nine separate feeders (ranging from 0.15 square inch to 0.025 square inch) was 0.10 megohm, including switchboards at both ends. This corresponds to a loss of only 350 units per annum; *i. e.*, fourteen units per mile of high-tension cable.

The insulation of the low-tension network is, of course, very much less, and can, with difficulty, be measured; if we include all switch-gear, network boxes and services, it may be about 1,000 ohms for fifty miles of cable, and at 200 volts there will be again a loss of seven units per mile of cable per annum, so that the total leakage loss is only 700 units per annum.

The insulation of a low-tension network may be of the order of ohms without being detected for a long time. A case in a neighboring system once came under the authors' notice in which there was a leak sufficient to raise a mass of concrete round a bunch of cables to a red heat before it was noticed; this is, happily, a very exceptional case.

The second cause of the loss—*viz.*, that due to C^2R in the cables—is of the greatest importance, and it also lends itself, in the case of feeders at least, to fairly accurate calculation. In the case of the low-tension network, however, the loss can only be approximately ascertained.

Table II gives the C^2R losses for the whole of the Croydon system of mains. They have been worked out for each quarter of the year, the basis of the calculation being the load curves shown in diagram 1, and the current in each separate feeder and distributor has been assumed to follow the same law as the total current. This is, of course, not strictly accurate, but is near enough for the purpose of this calculation.

TABLE II.

C^2R losses in cables.

Maximum load supplied: 1,250 kilowatts.

Description of Cables.	C^2R Loss in Units per Annum.
2,000-volt feeders and sub-feeders. About 25 miles. 0.15 square inch section to 0.025 square inch	47,200
400 and 200-volt distributors. About 50 miles, 0.40 square inch section to 0.10 square inch.	66,200
H. T. arc cables, 10.6 miles, 0.023 square inch section (series)	11,400
L.T. arc cables. About 20 miles, 0.06 square inch and 0.025 square inch section	25,800
Total	150,600

An exception has been made in the case of the public lighting load, as this, of course, follows a different law. The lower dotted lines in the diagram are the load curves for public lighting, and are calculated from diagram 2 as a basis, there being in this case a total of 400 arc lamps, 180 of which are switched off at about midnight. The greater part of these lamps are fed in parallel at 200 volts alternating, from low-tension mains used for no other purpose. These mains, however, take their supply from the same low-tension bus-bars in the substations as the private supply. There are, in addition, four high-tension series circuits, supplying together 134 lamps.

The upper dotted curves are the private lighting load curves for the respective quarters, and are used to calculate the C^2R losses in the low-tension network, in conjunction with the observed average

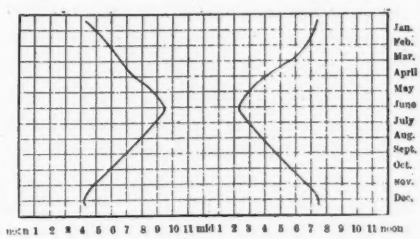


DIAGRAM 2.

drop in potential between the substations and consumers' terminals, which latter averages four or five volts.

We now pass on to the third heading—"Losses due to dielectric hysteresis," to use the term for want of a better one. After the very thorough way in which this question was discussed recently before this Institution, perhaps an apology is needed for again bringing up the subject. As the question was not finally settled, it was the intention of the authors to experiment thoroughly on the large system of high-tension cables at Croydon,

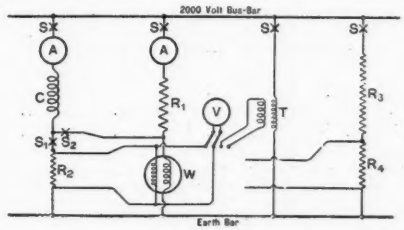


DIAGRAM 3.

and find out once for all what the true losses incurred in actual working were; an additional incentive was the desire to again demonstrate that, contrary to the usual belief, it was possible in certain cases to obtain a power-factor as high as 0.10 in a cable, as was stated to be the case in Mr. Mordey's paper and in Mr. Minshall's contribution to the discussion thereon. The latter is conclusively proved by the figures in table III.

The more ambitious scheme was doomed to partial disappointment, at any rate; it has been found a task of very great difficulty to obtain these losses with any reasonable accuracy with the instruments available in a fairly well-equipped test room. Numerous experiments have been made, owing to the interruptions due to the necessary routine of work of a central station in an exceptionally busy year, these results are somewhat meagre and inconclusive. This section of the paper is, therefore, rather of the nature of a series of suggestions, and it is hoped that the discussion will produce further data.

The methods employed for this investigation were:—

1. Direct measurement of watts used in the cable by a wattmeter, either with or without a choker, to improve the power-factor of the cable.

2. Calculation of watts from plotted curves of volts and current or from oscillograph records.

3. Direct measurement of increased power necessary to drive an alternator when a cable is switched on.

With regard to method 1, the first thing necessary to discover what reliance could be placed on the readings of the ordinary commercial wattmeters at our disposal, when used on various power-factors. Three wattmeters were used—*viz.* (1) a Swinburne with no unnecessary metal parts. This wattmeter had three different sets of current coils to give different sensibilities. (2) and (3) Thomson inclined coil wattmeters of different ranges with frames partly of metal. All three had large non-inductive resistances in series with the pressure coil, and were wound for 250 volts. The voltage was reduced in the ratio of about 10 to 1 by means of a bank of lamps, the actual ratio being measured for each set of readings; the voltage on the wattmeter was measured on a standard electrostatic instrument, and the full voltage was reduced by a transformer of known ratio and measured on the same voltmeter.

Diagram 3 shows the connections for calibrating the wattmeters initially; it is almost self-explanatory, and power-factors of about 0.03 and 0.35 with current lagging, 0.14 with current leading, and unity were used in the calibration. The leading current was obtained by passing a current through the series coil of the wattmeter in phase with the applied volts and connecting the pressure coil to a non-inductive resistance in series with a choker. The wattmeter is shown connected in this way in the diagram.

The power-factor of the ironless choker circuit, of course, can be calculated with very fair accuracy. The choker, as used throughout, consisted of 112 pounds of No. 16 copper wire wound on a wooden drum. A thermometer was embedded in the winding and the temperature was taken for each reading. The resistance, in series

with the choker, consisted of lamps. It has been assumed throughout that the lamp banks used were non-inductive, no difference in phase between current and applied volts being observable on the oscillograph used in these experiments.

The Swinburne wattmeter and the small range Thomson wattmeter gave fairly consistent results, although there were considerable variations with the different power-factors, chiefly due, in all probability, to the various wave-forms of the applied voltage. There were also variations in the constant obtained under the same conditions at different times, but as the constant used in working out the cable watts was that obtained under the most nearly corresponding conditions, and at the same time in most cases, the errors should not be large. Very low power-factors with leading current were not obtainable for calibration owing to the lack of a larger choker. In the case of the larger range Thomson instrument the constants vary from 6.6 to nearly 10, notwithstanding the maker's statement that the instrument is correct for all power-factors and all wave-forms; this apparently applies between certain limits only. The readings of this instrument were, therefore, rejected. In the later experiments, by a slight modification of the connections it was possible to calibrate the wattmeter in use, on a load with leading current, for every reading, and this was done in each case.

The actual connections used in the cable experiments are shown in diagram 4, two wattmeters being generally used in series as a check. Readings were taken, both with and without the choker C in parallel with the cable. L in the diagram is a bank of lamps, used in the earlier experiments in calibrating the wattmeters with a power-factor of unity. The arrangement on the right of the diagram at the bottom is for the purpose of calibrating the oscillograph. A voltage of 130, direct-current, could be applied to the oscillograph without altering the connections and the value of the deflection in volts thus obtained. In the same way a known direct current could be passed through the non-inductive current shunt R, and the value of the oscillograph deflection in amperes ascertained.

The principal results obtained are given in table III. In the four cases in which watts have been obtained, both from the oscillograph records and with a wattmeter, the two values are of the same order, but they do not agree as well as could be wished. This is, no doubt, explained partly by the shape of the waves. In curves of shapes E, F and G, for example, owing to the almost vertical-sided peaks, it is impossible to work out the watts even with approximate accuracy. A horizontal difference of 0.01 inch in the relative position of the curves of current and volts will totally alter the power-factor indicated. If it had been possible to obtain photographic records some improvement in accuracy would have resulted, but, as it is, with curves traced by hand, very little reliance can be placed on the worked out power-factor of the very peaked waves. On the other hand, simpler wave-forms can be worked out fairly accurately; curve D, for example.

Referring again to the table, it will be noticed that very great discrepancies occur between various sets of readings on the same cable and also between the results obtained with the choker in parallel with the cable and without it. The former results should be the more accurate, owing to the higher power-factor. Such figures are not very conclusive, but they have been obtained with all proper precautions, and it is hoped that some explanations of the discrepancies may be suggested.

Part of the differences may be due to the effect of alteration of wave-form (1) on the actual losses, and (2) on the instrument indications. It has not been definitely proved whether the power-factor of a cable is altered by alteration of the wave-form of the applied voltage or not. On the whole, it may be inferred that it is altered to some extent, but not largely. With wave-forms as in curves E, F and G, the power-factor for a long paper-insulated cable comes out at about 0.014, averaging the three, and with curves H, I and J for the same cable and approximately the same voltage it is 0.08. A wattmeter was not used in this case. This

TABLE III.—DIELECTRIC HYSTERESIS LOSSES IN HIGH-TENSION CABLES.

Experiment No.	Date of Experiment.	Cable No.	Description.	Length of Yards.	Section. Square Inches.	Capacity Mfds.	Insulation Ω	Applied Volts.	R. M. S. Volts by Oscillograph.	Current. Amperes.	R. M. S. Current by Oscillograph.	Voltamps. by Ammeter and Voltmeter.	Watts by Wattmeter.	Watts by Oscillograph.	Power-Factor by Wattmeter.	Power-Factor by Oscillograph.	Corresponding Curves.	Remarks.
1	21-7-01	4	Conc. jute insulated, lead sheathed, armored, direct in ground.	2,100	0.10	0.50	220	2,080	..	0.709	..	1,474	30	..	0.020	..	Applied volts as curve 12, sheet B.	Ironless choker in parallel.
2	8-9-01	4						2,070	..	0.828	..	1,710	49	..	0.029	..		Cable alone.
3	6-9-01	4						2,057	..	0.740	..	1,520	25	..	0.017	..		Choker in parallel.
4	14-7-01	7	Conc. V. B. insulated, laid solid in iron trough with iron cover, designed for 5,000 volts, worked at 2 000 volts.	7,290	0.10	3.46	50	2,075	..	3.14	..	6,520	635	..	0.098	..	Cur'ent wave not taken.	" "
5	21-7-01	7						2,075	..	3.58	..	7,530	830	..	0.112	..		" "
6	4-8-01	7						2,100	2,245	3.28	3.03	6,890	866	610	0.126	0.090	B	
7	21-7-01	7						2,075	..	3.66	..	7,600	854	..	0.112	..	As Exp. 5.	Cable alone.
8	4-8-01	7						2,090	2,205	3.40	3.43	7,110	923	835	0.130	0.110	A	" "
9	4-8-01	9	Conc. jute insulated V. B. sheathed, laid solid in wood trough with No. 10	2,440	0.15	0.69	50	2 083	2,155	1.058	1.058	2,205	58	76	0.023	0.033	C	" "
10	8-9-01	9						2,078	..	1.072	..	2,230	66	..	0.030	..	Applied volts as curve 12, sheet B.	Choker in parallel.
11	8-9-01	9						2,087	..	1.003	..	2,090	33	..	0.025	..		
12	8-9-01	10	Conc. paper ins. V. B. S., laid solid in iron trough with tile cover, W. P. 5,000 volts.	2,400	0.15	0.223	2	2,082	..	0.737	..	1,535	112	..	0.073	..		Cable alone.
13	8-9-01	10						2,106	..	0.665	..	1,380	33	..	0.024	..		Choker in parallel.
14	4-8-01	Choking coil	112 lbs. No. 16 S. W. G. copper; wound without iron.	..	..	..	..	2,060	2,070	2.70	2.68	5,560	Calc. 178	175	Calc. 0.032	0.0315	D	Ironless choker, no cable.
15	-10-02	11	Concent. paper insulated V. B. S., laid solid in iron trough with tile cover, working pressure, 5,000 volts.	6,340	0.10	0.50	50	4,920	4,840	3.83	..	18,740	..	237	..	0.0127	E	Oscillograph voltage strip only calibrated. Watts worked out from curves and the measured R. M. S. values of voltage and current. For I, J and K neither strip was calibrated.
16	-10-02	11						4,175	4,110	3.24	..	13,530	..	237	..	0.0175	F	
17	-10-02	11						1,686	1,656	1.14	..	1,920	..	20.3	..	0.0106	G	
18	-7-02	11						5,700	..	4.50	..	25,650	..	2,130	..	0.083	I	
19	-7-02	11						4,000	..	3.00	..	12,000	..	965	..	0.080	J	
20	-7-02	11						2,480	..	1 60	..	3,970	..	309	..	0.078	K	
21	-10-02	12	See Note (i.) at foot.	41,660	See Note (i)	5.39	0.71	2,000	1,947	6.08	..	12,160	..	901	..	0.074	L	
..	..	..	.....	..	..	..	..	..	..	..	..	..	..	..	..	..	H	Sine curves equiv'nt to E.

NOTES.—(i.) Cable No 12 consisted of cables Nos. 9, 13, 14, 10, 11 and 7 joined in series, making 12.3 miles in all. No. 14=1,650 yards of same type as No. 9 and No. 13=1,640 yards of same type as No. 10. (ii.) Worked out result of curves E, F and G, probably very inaccurate, owing to very peaked waves. (iii.) Thomson wattmeter used in series with Swinburne in experiments Nos. 6, 8, 9 and 14. Watts agree with Swinburne, with maximum variation of 10 per cent. (iv.) No wattmeter used in experiments 15 to 21. Watts worked out from oscillograph curves only. (v.) The Swinburne wattmeter with original fine wire coil was used in experiments Nos. 1, 4, 5, 6, 7, 8 and 9. It was used with coil rewound with No. 26 S.W.G. wire in experiments Nos. 2, 3, 10, 11, 12, 13.

enormous difference can not be put down wholly to the difference of wave-form, but is most probably due to the inaccuracy in working out the very peaked waves of the first set of curves, and the agreement of the three is probably more coincidence than anything else. The

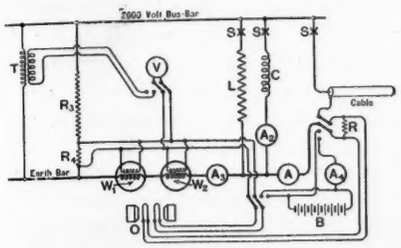


DIAGRAM 4.

value obtained from the last three curves has been taken as the more probably correct.

With regard to the effect of wave-form on the other instruments used, it is stated by Benischke that there may be a difference of ten per cent in the readings of electromagnetic instruments with flat and peaked waves. In calibrating the various instruments used, differences amounting to about five per cent were found when using different wave-forms, the substandard being a Siemens dynamometer with practically no metal parts in the frame, and this should read sensibly the same for different wave-forms and frequencies. The Thomson ammeters read higher on the smoother waves. In working out the experiments the calibration with the particular wave-form of the experiment was that used.

It was found that the voltage across the terminals of the current coil of the Swinburne wattmeter (using the fine wire coil) varied in the ratio of about 1 to 3 in the various experiments owing to the difference in the current frequency. It is difficult to say to what extent a wattmeter may be relied on when the current has about double the frequency of the applied voltage. In order to overcome the difficulty of very small scale readings on the wattmeters, the current coils were in most cases heavily overrun, a short-circuiting switch being put in except when taking readings.

It is interesting to note that in one experiment, not recorded in the table, the wattmeter gave a higher reading when short-circuited than when the current coil was in circuit, no doubt due to currents induced by the voltage coil, which was in circuit. In all the recorded experiments the measuring instruments were placed in the earthed outer of the cables, as it was found that the readings were practically identical with those obtained with the instruments on the inner, and the safety of the arrangement was much greater.

It was considered a matter of interest to find out how the wave-forms and values of current and voltage varied at different points in the length of a cable, if at all. Six long cables were joined in series, and readings of current and voltage and tracings of the wave-forms were taken at each end and at the junction of the two middle cables. The readings taken at the end at which the voltage was applied are recorded in experiment No. 12, table III, as are also the lengths and sections of the various cables. The results of this particular test showed that, contrary to the authors' expectations, there was no observable difference, either in the voltage, or in the wave-forms of the voltage and current at the three points. The middle point was at the junction of cables Nos. 10 and 11. The current, of course, had different values at the three points, but whether it and the watts were in proportion to the equivalent length of the cable can not be stated with certainty, as the cables are of different types and sizes. This experiment was made under different conditions: (1) with the cable open-circuited at the far end, and (2) with a small non-inductive load at the end. The results were the same in both cases, except for a very slight reduction in the "kinks" in the voltage curves in the latter case, and a slight shifting of the current wave owing to the higher power-factor. The result is the more remarkable, as it is the generally accepted view that in all long cables there is a rise of pressure due to the capacity; and, under certain conditions, this does undoubtedly take place. In all probability a variation of frequency would have produced the result expected. It is unnecessary to show the curves obtained at the three points, as they are all practically alike.

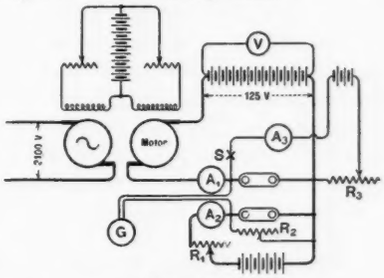
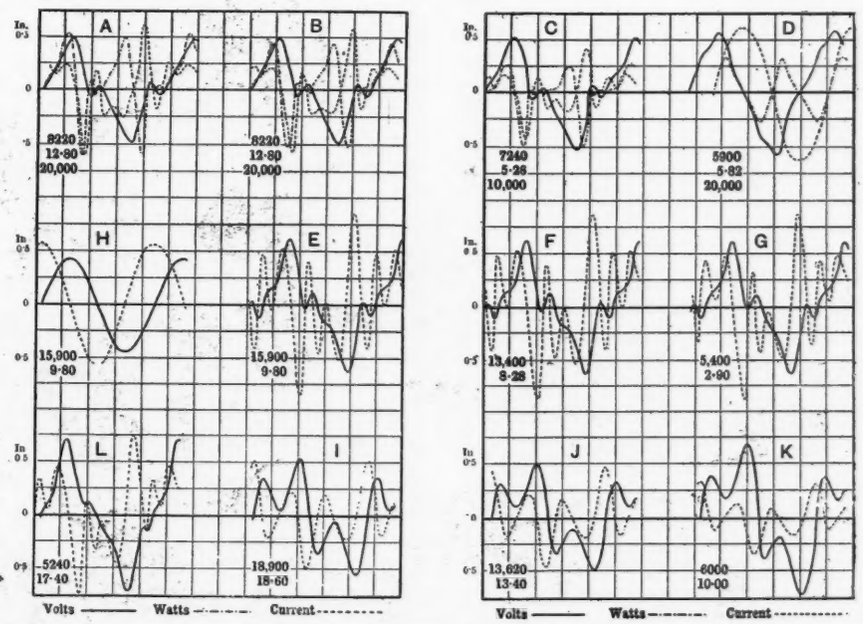


DIAGRAM 5.

In addition to the above experiments, it was sought to confirm the results by the motor alternator method. The connections of the direct-current motor were as shown in diagram 5, the current being measured by a very sensitive differential method, which is clearly shown in the diagram. The galvanometer was calibrated by adding a small known current to the motor current and noting the scale deflection; the scale was a proportional one.

While this method was applicable to the vulcanized bitumen cable, giving the watts taken by the cable rather lower than the results obtained by the other methods, it was found that when the jute cables were switched on less current was taken by the motor than before, no doubt owing to the efficiency of the alternator being improved by the alteration in wave-form. This does not include the increase of efficiency due to the reduced exciting current, as the exciting current was separately measured.

(To be concluded.)



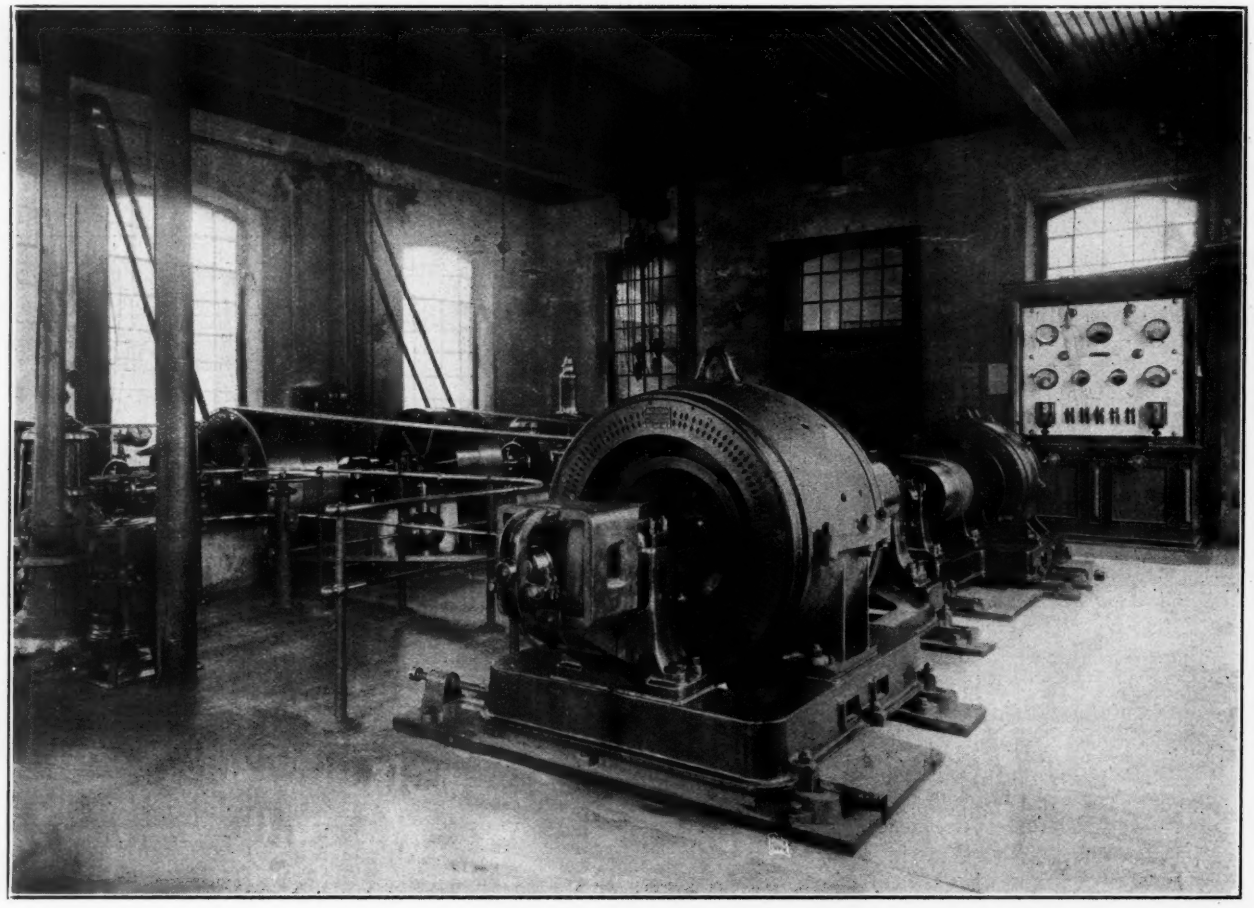
WAVE-FORMS IN CABLES—SEE TABLE III.—THE FIGURES EXPRESS THE RESPECTIVE VALUE PER MIL OF VERTICAL HEIGHT, OF VOLTS, AMPERES AND WATTS.

The Hallau Monophase Light and Power Plant.

By Frank C. Perkins.

THE town of Hallau is located not far from Schaffhausen, Switzerland, and is supplied with light and power from a hydroelectric plant located at Wunderklingen, 4.5 kilometres (two and three-quarter miles) from the town. The water is taken from the river Wutach at a point 4.5 kilometres (two and three-quarter miles) from Unterhallau, where the minimum flow is 1,400 litres (49.5 cubic feet) per second. At the power-house there is a normal flow of 2,200 litres (77.6 cubic feet) with a net fall of 7.75 metres (25.5 feet). The dam has a total length of thirty metres (99 feet), and is located 1,400 metres (9,620 feet) from Wunderklingen. The water is conveyed to the power-house through a canal 1,200 metres (3,950 feet) in length, and a wrought-iron pipe 1,500 millimetres (4.8 feet) in diameter and 150 metres (480 feet) in length.

The Hallau power-house is equipped with three turbines built by Benninger & Company, of Uzwil. The smaller turbine has a capacity of twenty-five horse-power and each of the others has an output of seventy-five horse-power. These turbines are of the vertical Girard type, and operate at a speed of 110 revolutions per minute. They are geared to a horizontal counter-shaft and operate the electrical generators, as well as a large pump, by a belt transmission and gearing.



INTERIOR OF HALLAU MONOPHASE PLANT.

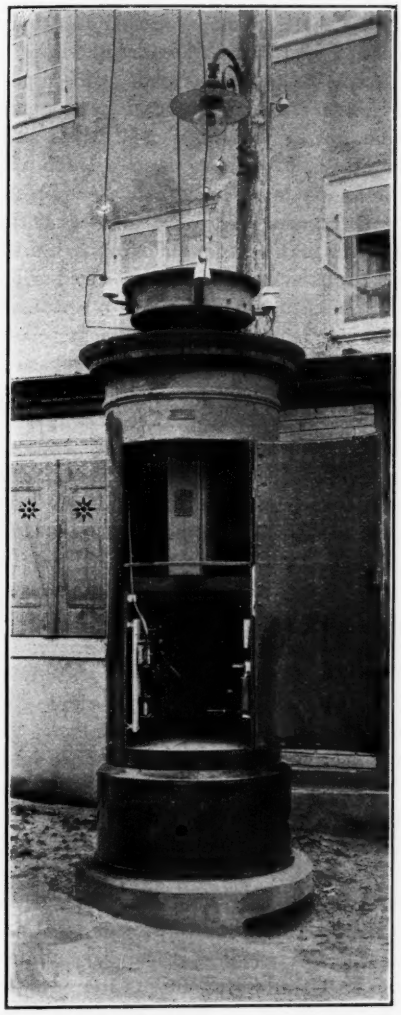
The electrical plant was installed by the Maschinenfabrik Oerlikon, of Oerlikon, near Zurich, Switzerland, and consists of two single-phase alternators supplying a current of 3,200 volts pressure, the frequency being fifty periods per second. The first generator installed has a capacity of 49.7 kilowatts, with power-factor of one, and operating at a speed of 600 revolutions per minute. The last generator installed has an output of seventy kilowatts with power-factor of one, and a speed of 500 revolutions per minute. These machines are both of the inductor type, and the exciters are mounted on the same shaft as the alternator outside of the main bearing.

The switchboard includes panels for both the high-tension alternating-current controlling apparatus, as well as for the exciting machine. It is constructed of marble with an iron framework, and is equipped with the usual ammeters, voltmeters, switches and rheostats.

The primary transmission line is 4.5 kilometres (14,850 feet) in length, and consists of two copper conductors, each 5.5 millimetres (220 mils) in diameter, supported by double porcelain insulators on wooden poles. The transformer substations for the light and power distribution circuits are of the cylindrical type, 2.8 metres (92 feet) high and 1.2 (31 feet) metres in diameter. One of these substations is equipped with a twenty-kilowatt transformer, and the other two each with fifteen-kilowatt transformers. In each of these substations there are marble switchboards, on which are mounted high-tension circuit-breakers, lightning

arresters, and the usual switches and fuses for the low-tension distribution. The secondary conductors are installed on the three-wire system, the pressure between each pair being 124 volts, and the loss on the line twenty per cent.

There are a total of 550 incandescent lamps of sixteen candle-power for the private lighting service, while for the public street lighting fifty-four lamps of twenty-five candle-power are employed, the loss on the latter service being only



HALLAU TRANSFORMER STATION.

two per cent. The Hallau power circuits supply motors up to twenty horse-power in capacity, seven motors being employed, having a total output of twenty-eight horse-power. The plant operates day and night, closing down for an hour between one and two each noon. The method for charging for current at this plant is somewhat peculiar. There are two classes, the first for living rooms, kitchens and workrooms, where the charge is one franc per year per candle-power. The second class includes sleeping rooms, cellars and halls, and the charge for current for this service is fifty centimes (ten cents) per year per candle-power.

The Annual Report of the Director of the National Bureau of Standards.

The annual report of Director S. W. Stratton, of the National Bureau of Standards, Washington, contains an account for the year ending June 30, 1902, of what has been accomplished so far and an outline of the proposed work for the future. The bureau was established by Act of Congress, July 1, 1901, superseding the office of Standard Weights and Measures of the Treasury Department.

SITE OF THE BUREAU.

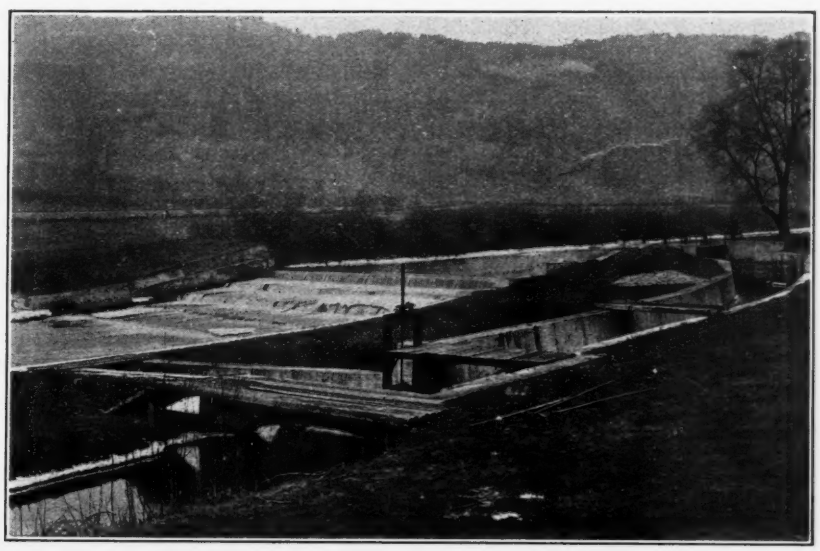
The site secured, which is particularly free from mechanical and electrical disturbances but sufficiently easy of access, consists of about seven and one-half acres in the neighborhood of Washington. This site, while sufficiently large for the necessary buildings of the bureau, is not large enough to ensure these buildings from disturbances when the neighborhood in which the bureau is situated becomes more completely settled, and it is recommended that the government secure the remaining portions of the block upon which the buildings are.

TEMPORARY QUARTERS.

Temporary quarters were secured in order that the staff bureau might be thoroughly organized and some preliminary work might be carried on. These quarters consist of eight rooms in the Butler Buildings, eight rooms in the Coast and Geodetic Survey Buildings, and a large four-story residence building on New Jersey avenue. This will provide space for the collection and testing of the apparatus to be used in the new laboratories.

PLANS FOR THE NEW LABORATORIES.

The work for which the National Bureau of Standards was established includes research and testing in the domain of physics, extending into the field of chemistry on the one hand and of engineering on the other. The laboratory requirements are those of a research laboratory, and in addition special facilities that may be needed for commercial testing. Two buildings have been planned; one being the mechanical laboratory and the other the physical laboratory. The mechanical laboratory contains the mechanical plant, instrument shop, and laboratories for the heavier kind of experimental work. It will be connected with the physical laboratory by a spacious tunnel.



HYDRAULIC INSTALLATION FOR HALLAU MONOPHASE PLANT.

PHYSICAL LABORATORY.

The physical laboratory will provide for that part of the experimental work which should be kept free from mechanical and magnetic disturbances. It will also contain the office for administration, the library, and a well equipped chemical laboratory. No pains will be spared to secure the proper conditions for experimentation. The rooms will be well lighted, the windows being double to avoid changes in temperature and drafts. The temperature of each room will be automatically controlled by a thermostat, the heating or cooling of each room being effected by mixing hot and cold air. Thus it will be possible to regulate the temperature of each room in summer and in winter at will by setting the thermostat to the desired point. All windows will be provided with light-tight shutters.

The building is 172 feet long and 53

feet wide, and has four stories with an attic and a basement. It will be of extra heavy construction and the first two stories will be reserved entirely for experimental purposes. The design is such that wings can be added in the future, should they be needed.

WEIGHTS AND MEASURES, THERMOMETRY.

In these departments the bureau will design a standard set of weights. It will undertake verification and stamping of chemical glassware, and will make a study of hydrometers. The work in thermometry will be extended to cover temperatures varying from minus 190 degrees centigrade to 1,500 degrees centigrade.

ELECTRICAL STANDARD.

A laboratory has been fitted up for the verification of standards of resistance and electromotive force. A primary mercury standard of resistance will be constructed, to which secondary commercial standards will be referred. Facilities are now provided for the verification of resistance boxes, ratio coils, potentiometers and other classes of apparatus.

A number of Clark standard cells, legalized by Congress as a standard of electromotive force in the United States, have been constructed from chemically pure materials obtained from a number of different sources, and also from the same materials subjected to further purification. An investigation will be undertaken to ascertain the cause of the variation of the electromotive force of the Clark cell. A number of Weston cells have been set up and these will be compared with each other and with the Clark standard cells.

It is probable that the bureau will undertake the redetermination of the electrochemical equivalent of silver, upon which the legal definition of the unit of current is based, since the value adopted is not consistent with the definition of the ohm and the volt.

THE VERIFICATION OF AMMETERS AND VOLTMETERS.

One of the temporary laboratories has been fitted up for the calibration of voltmeters and ammeters, and while the range is at present limited to 150 volts and 50 amperes, apparatus will soon be installed for increasing these ranges to 2,000 volts and 1,500 amperes. A comparative study of the different makes of American instruments will be made after the working standards of the bureau have been calibrated.

ALTERNATING-CURRENT LABORATORY.

An alternating-current laboratory is being fitted up and orders have been placed for specially designed single-phase and multiphase alternators, to be direct-connected to independent direct-current motors. Especial attention will be given to the comparative study of the methods of determining wave-form. The determination of electrostatic capacity and the investigation of dielectric hysteresis will also be given special attention, as will also the verification of standards of self and mutual inductance. Facilities will be provided for the verification of alternating-current experiments.

MAGNETIC WORK.

No work along this line has been undertaken, but facilities will be provided without delay. Investigation as to the influence of treatment and chemical composition on the magnetic properties of iron and steel will be taken up as soon as time permits.

PHOTOMETRY.

One of the rooms in the temporary laboratory has been fitted up as a photometric laboratory, with the latest type of comparing apparatus. A complete study of the Hefner standard will be made and the different methods which have been proposed for the realization of a better primary standard will be investigated.

THE LIBRARY.

The bureau received during the year about 700 volumes. The appropriation permitted the purchase of only a few of the books and journals needed for the scientific work, and at the present time new lists of necessary books have been laid aside for lack of funds, an adequate reference library is a fundamental requisite in a scientific and research laboratory. A librarian is needed to take charge of the books, to prepare a subject catalogue, to attend to the work of compiling needed bibliography, and to prepare journals and pamphlets for binding. Such a librarian could be of great assistance in the preparation of technical bibliographies of scientific subjects for immediate use in the technical work of the bureau.

TESTS MADE DURING THE YEAR.

During the year 743 tests were made for the government and 312 for the public. The value of these tests was $1,316.40, $252.05 being paid by the public.

The office has been thoroughly organized for efficient and prompt handling of the rapidly increasing work of the bureau.

Abstract of a Statement Made by Mr. John M. Bowers, of the Consolidated Gas Company, at Legislative Hearing at Albany, N. Y.

At a legislature hearing in Albany, on April 7, 1903, Mr. Bowers made a statement in behalf of the Consolidated Gas Company, to refute the statement and estimates made by Mr. Robert G. Monroe, commissioner of Water Supply, Gas and Electricity of New York city, regarding the probable cost to the city of a municipal lighting plant.

The main points suggested in the report of Mr. Monroe are the questions of the cost to the municipality of ordinary gas lamps, the cost of incandescent mantles, and the cost of electric lights. The average cost to the Borough of Manhattan for its gas lamps is $15.70 per lamp per year. Figures are given to show that this is lower than charges made in most of the cities of the country for the same service. In discussing the question of incandescent gas lamps, it was stated that those used in Chicago—to which comparison was made—are not the Welsbach lantern, but are of a totally different character. The Chicago lamps are not as handsome as the Welsbach lantern, and do not give the same amount of light. It was also pointed out that in a number of the cities cited the street lamps are run on the "moonlight" schedule, and a direct comparison with the New York lamps is, therefore, not fair.

In Mr. Monroe's report it was stated that the average price to sixty-eight cities throughout the country for arc lamps was $88.60 per lamp per year, and this figure was compared with the present rate in the Borough of Manhattan of $146 per lamp per year. On analyzing the table prepared by Mr. Monroe, Mr. Bowers shows that the electric plants in some of the cities specified are operated by water power, and many of them have limited light schedules of 3,500, 3,650 and 3,800 lighting hours per year, instead of 3,950 as required by the New York schedule. In many of the cases selected the current supplied is far less than required in New York. In almost every case the service is largely, if not entirely, overhead, with wooden poles and outriggers; and in but one instance is the service entirely underground, as in the Borough of Manhattan. It seems apparent, therefore, that the general figures collected by Mr. Monroe form no basis for a comparison with the fair cost of electric lights in the city of New York.

The main basis of comparison, how-

ever, that is made by Mr. Monroe, is the cost of electric lighting to the city of Chicago. It is claimed in his report that the total cost to that city, by reason of the operation of its municipal plant in the year 1902, for electric lighting, per lamp of 2,000 candle-power, was $53.51. Reference was then made to the analysis of the report of the city of Chicago, as corrected by Haskins & Sells, which showed that the cost per lamp for its municipal system of electric lighting, for the entire period of its existence—that is, from the year 1888 to and including 1900—was at the rate of $165.62. It seems, therefore, scarcely reasonable to select a particular year, in which it is claimed that the cost of operating was below the average, as a basis of comparison. Neither can any comparison safely be made with such cost, for the reason that items aggregating a large amount are wholly omitted in the preparation of the figures.

The investigation made by the city of Boston of the Chicago plant for the year 1898, for which year an estimate of $87.38 per lamp per year had been given, showed that omitted items raised this figure to the sum of $153.03, and this latter cost, by the addition of certain items of difference existing between Chicago and Boston, was increased to the sum of $154.80 for Boston conditions. The latter item would have been $170.40 had Boston's system been entirely underground, as is the case in the Borough of Manhattan.

There can be no doubt that the cost of supplying public lighting to the municipality of the city of New York is at least as great, if not greater than, to the city of Boston. The mere cost of the real estate essential for the use of the plant will, in itself, considerably increase the cost of production. The land on which the Boston electric station is built cost thirty cents per square foot, while the land on which the waterside station of the New York Edison Company is built cost at the rate of $5.75 per square foot.

Referring to the Detroit service, but ten per cent of this is underground. The current is less, and the lighting schedule is but 3,744 hours. The cost of operating this plant was also examined by the Boston authorities. The rate given for the year 1897 was $53.06 per lamp. The omitted items, as estimated, raised the cost to that municipality to the sum of $111.74; and this when compared with the basis of cost in Boston, was increased to the sum of $134.57, which would be still further increased, if compared with an underground system, to the sum of $152.45.

Comparing the cost to the city of New York with that to Chicago, during the entire existence of the municipal plant, the bids made for electric lighting to the city of New York were $19.62 better. Based upon a comparison with the cost in 1897 in the city of Chicago, and increased in accordance with the difference in cost by the difference in local conditions, the bid in New York is $24.40 better.

Attention was called to certain disadvantages under which the New York companies labor. They are not allowed to repair the pavements which they find it necessary to remove, and are also compelled to employ inspectors, appointed by the Department of Highways, in addition to their own.

The five important cities that have undertaken or seriously considered municipal ownership are Chicago, Detroit, Boston, Philadelphia and Worcester. The city of Philadelphia for many years maintained its own public lighting plant, but at such an enormous loss that it was glad to abandon the plan and lease its plant to a private corporation. In 1901 the city of Worcester investigated the question of municipal ownership. The result of enquiries made was that the average cost per lamp-hour of the street lamps was for a 500-watt lamp 4.58 cents per lamp-hour. At the present bid of the New York Edison Company, a standard arc lamp, at four to one hundred hours per annum, costs 3.56 cents per lamp-hour. It is thought, therefore, that the result of the Philadelphia - Worcester - Boston investigation justifies the conclusion that the Consolidated Gas Company has in the past, and will in the future, supply the city with municipal lighting of every kind at a far less expense than would result from any municipal ownership.

SOME DIFFICULTIES OF LONG-DISTANCE ELECTRIC TRANSMISSION.[1]

BY PAUL M. LINCOLN.

The difficulties in long-distance transmission may be subdivided into those which are imposed by man and those which are imposed by nature. The man-imposed limitations are such as malicious interference, carelessness and the use of bad or inadequate methods. The natural limitations, on the other hand, are those imposed by the problem of insulating for high voltages, of taking care of lightning discharges and of the relative cost between electrically transmitted power and that generated at the point where it is to be used. The various troubles brought on by careless or thoughtless persons and by animals, and the precautions to be taken to avoid them were discussed.

Referring to the use of rubber insulation for inside wiring, the experience of the writer has been that for high-tension insulators rubber is not reliable. His first experience came at Niagara Falls some years ago. At the time of raising the voltage on the Niagara-Buffalo line from 10,000 to 20,000, a change in arrangements made necessary the rewiring of the transformer stations, in so far as the high-tension end was concerned. For this purpose there was used a wire covered with a first-grade of rubber insulation. A number of tests were made on short sections, and the insulation on none of these tests broke down short of 70,000 volts. An entire reliance was placed on the insulation of the rubber and no particular pains were taken therefore with the mountings. These mountings were small clamp porcelains. Before the job was put into service it was given a test as a whole of 50,000 volts for ten minutes, which it stood perfectly. After one week of operating on 20,000-volt, three-phase circuit, two breaks occurred in the rubber insulation. The normal voltage strain on this insulation was only about 13,000 volts, so that there was a factor of safety of at least five. Both the breakdowns occurred at the mountings, where in order to get to the ground it was necessary to both puncture the rubber and pass over about one inch of porcelain surface. It has been noticed that whenever any conductor is brought near the surface of a high-voltage cable, a brush discharge of more or less intensity takes place at the surface of the cable. The breaks in the insulation are most certainly caused by some chemical action on the rubber, caused by this discharge.

Within the last ten years the voltage for transmission purposes has been increasing; not gradually, but by leaps and bounds. Ten years ago 4,000 or 5,000 volts was most unusual; to-day ten times that amount is in use, and a voltage as high as 80,000 has been proposed by conservative engineers. But it seems probable that the loss of power in brush discharges from the surface of the conductors, as well as the disintegrating effect that this brush discharge is likely to have on the metal of the conductor, will place a limit at no very great increase.

The use of glass and porcelain insulators was then discussed, the value of lightning arresters spoken of, and reference was made to the work of the high-tension transmission committee of the American Institute of Electrical Engineers.

[1] Abstract of a paper read before the Electric Club, of Cleveland, April 1.

Notes from Great Britain.

By Our Special Correspondent.

THE Metropolitan company has let the contract for the complete electrical power-house, plant, trains, line equipment, etc., to the British Westinghouse Company. The power-house, which will be built close to the company's main line on its own land—the company owns over sixty miles, apart from the Inner Circle—will at first contain four 3,500-kilowatt steam turbine-driven sets, which will generate three-phase current at 11,000 volts, to be converted at substations and transformed down to 600 volts continuous current. Corridor trains are to be employed, seven coaches forming a train, accommodating 500 passengers. Multiple control will be adopted, and the motor cars, of which there will be one at either end and one in the centre, will each be equipped with four 150-horse-power motors. Over sixty miles will be converted to electric traction, and the matter is being taken seriously in hand. The company claims that no other installation of this magnitude is contemplated in Great Britain, and the general manager, while ridiculing any suggestion of the buying up of his company by Mr. Yerkes—as had been hinted in certain quarters—states that the two parties are working along very smoothly as regards the service and conversion of the Inner Circle. The Royal Commission on London Traffic can, of course, have no effect upon this undertaking, but it is interesting to note that practically all the bills seeking new "tube" lines in London have been suspended until the report of the commission is published, which some people prophesy will be in about two years' time. It is certain that the commission has an enormous field of reference, and very few agree with this policy of suspension, which is similar to that adopted when a joint committee went into the same problem two years ago.

I mentioned some time ago that a committee had been appointed, which included among its members the president of the Institution of Electrical Engineers, to enquire into the dangers attending the use of electricity in mines, and to consider the advisability of framing regulations. A number of sittings have now been held by this committee, but not a great deal of technical evidence has as yet been called for. Every one seems agreed that regulations are needful, but none will venture suggestions as to their nature. Many suggestions, however, have been forthcoming as to the manner of carrying the cables along the mines to prevent fracture and explosions of gas through arcing, and the utility of totally enclosed motors and coal-cutting machines and other precautions. Probably for the first time, the next meeting will be public, so that a better idea of the views of witnesses will be forthcoming.

The report of the Post Office Telegraph Department shows that the deficit in this public service now amounts to nearly $5,000,000, and many people wonder why no official explanation is ever forthcoming. A question was put to the Postmaster-General in the House of Commons the other day *apropos* of this, and the reply was that no useful service would be accomplished by the appointment of a committee to enquire into the matter, as was suggested. The questioner was told that the public preferred facilities as a return upon their money. At a recent date, too, a deputation waited upon the Postmaster-General, urging the increase of the underground telegraph wires to the North of England and Scotland. During the recent gale much damage was occasioned to the open-air service, and the reply elicited was the most encouraging that has been meted out for a long time; *viz.*, that the government proposes to ask for £131,000 to accomplish this object.

Matters relating to telephony are now rather quiet, and very little of importance can be reported. Customers of the General Post Office in the West End of London have been complaining that although their wires have been laid for eighteen months there seems little prospect of connection to a switchboard. The reason for this would appear to be some delay in the acquisition of a site for the exchange, and the best that can be offered at present is a further delay of over six months. The Secretary for Scotland has authorized the Glasgow corporation to borrow an additional £80,000 for the purposes of the municipal telephone system, and the Tunbridge Wells system has now been quietly handed over to the National company. By the way, it is noteworthy that the National company is building a new exchange in Glasgow on a different system from that adopted by the corporation; another instance of a difference of opinion as to what is up-to-date practice.

At the annual meeting of the electrical section of the London Chamber of Commerce, attention was drawn to the work of a special committee, designated the Earth Returns Committee, which has been successfully employed in combating the attempt of the gas and water companies to throw the onus of the question of alleged electrolysis of their pipes upon electricity supply undertakings. The committee in question, in cooperation with the Tramways and Light Railways Association, has interviewed the authorities of Parliament and enlisted their sympathy on the side of the electrical industry, with the result that the threatened injustice referred to has been averted and the onus properly apportioned. Other good work accomplished by the electrical section of the London Chamber of Commerce during the past twelve months has been the support of the Institution of Electrical Engineers in its deputation to the Board of Trade *re* electrical legislation, and many other matters of minor importance but having a great bearing upon the industry.

A peculiar libel action has just been averted in the law courts here. An action for libel was pending on the part of Mr. Henry Wilde, F. R. S., against Dr. Silvanus P. Thompson, F. R. S., for using the word "dynamo" in connection with other machines than those devised by Mr. Wilde. On the face of it, the action seemed absurd, inasmuch as this was the first time that any man has laid a claim to the exclusive use of a word in the English language. Dr. Thompson, however, appealed to the courts to quash the action on the ground that it was a frivolous one, and the courts have decided in favor of him, the judge remarking that he had a difficulty in giving his decision with becoming gravity.

The Institution of Electrical Engineers has just issued a set of general rules recommended for wiring for the supply of electrical energy. A great deal of labor has been expended in bringing to bear upon the drafting of these rules the very latest practice, owing to what the Institution has considered the divergency and incompatibility of the existing rules issued by fire officers and

others. It is hoped that this new set will supersede the old ones, and thus gradually introduce uniformity and standardization. They are to be sent to supply engineers, consulting engineers, fire officers and contractors, and a standing committee will promptly deal with all suggested improvements. The list of rules is a very complete one, and includes a table showing maximum currents, thickness of dielectric and insulation resistance for copper conductors, insulated and laid in casing or tubing. The multiplicity of present wiring rules rendered necessary some such action as has been taken by the Institution, and it is to be hoped that they will be well received in all quarters.

At the British Institution of Electrical Engineers on February 26, Mr. J. Stottner gave an interesting account of what has been done in Germany with the Nernst lamp, a piece of electrical apparatus which has, during the past few years, been gradually gaining ground in Great Britain. In an attempt to discover a substitute for the carbon filament, with its vacuum globe, Jablochkoff took out a patent in 1877 for a lamp in which the illuminating body consisted of kaolin and similar refractory earths, which became conductors of electric current as soon as heated to a certain temperature. This lamp had a very low efficiency, however, and also necessitated very high-tension currents, and, as well as many other attempts which Mr. Stottner did not enumerate, proved a failure. Coming at once to the invention of Professor Walther Nernst, in 1898, various stages of its progress were detailed. The filaments of all these lamps are now made of rare earths, principally zirconia. The earlier types had no automatic heater, and the filament or glower had to be heated to a temperature of about 900 degrees centigrade by means of a spirit lamp or match, in order to make it a conductor. The very first lamp brought out had a straight filament, the compensating resistance (or bolstering resistance, as it is termed on the Continent) of which consisted of a fine platinum wire and was arranged in parallel with the filament at a distance of about one-quarter inch. The second type had its filament bent in a similar manner to the first Edison bamboo carbon incandescent lamp, and was in the shape of a horseshoe, the burner could be exchanged, and the globe was open at the bottom to facilitate the artificial heating of the filament. The bolstering resistance consisted of fine platinum wire wound around two small porcelain tubes, and was exposed to the air to obtain a better cooling effect. The next improvement was to wind the bolstering resistance on one small porcelain tube only, and to partly cover it with kaolin. Then the resistance was made of thin iron wire wound on a very small kaolin tube, which was sealed and enclosed in a glass tube, which was evacuated and filled with hydrogen gas. Platinum was, however, again resorted to for the resistance, and in the fourth type of lamp a large loop consisted of the resistance, very similar to that employed at present. In this type, too, the filament and resistance were fixed on a porcelain base. All the lamps hitherto, however, suffered under the difficulty that they had to be heated by means of a spirit lamp or match, and the Paris Exhibition of 1900 forcibly brought home to the German manufacturers the vital necessity for automatically heating the filament. In the sixth pattern of lamp turned out, the design assumed very much the shape of the present-day product. It had a heater in the form of a coil, in the centre of which the filament was placed. The remainder of the parts remained fairly constant, but the filament was arranged vertically to the base. After this, with but few modifications, the lamps were, for the first time, produced in large quantities in two types: "A" type, with large body and globe, and "B" type, with small, round globe and body, so arranged that it could be used in an ordinary Edison screw lamp socket.

The "A" lamps were for currents up to one ampere and had to be separately connected in a similar manner to an arc lamp. They were manufactured for an energy consumption of forty to eighty watts, and potentials of 110 and 220 volts, respectively. The bolstering resistance consisted of platinum wire, as in the majority of the earlier types. In this type, too, the magnet of the automatic cutout received its final shape, being marked by very small masses of iron and a very light spring, and, in consequence thereof, a very small amount of energy. Nowadays, the "A" type of lamp is manufactured for one ampere up to 150 volts, and for one-half and one ampere up to 250 volts.

Mr. Stottner, who showed a whole range of specimens of the progress of the lamp from the beginning, concluded his short account by remarking that, after a study of the designs and principles of the Nernst lamp manufactured in the United States, he had come to the conclusion that Europe was at least as up to date as America. A W.

London, England, April 4.

Electric Lighting in a Dynamite Factory.

The dynamite factory of Filiale Leimbach, at Mansfield, Germany, at the beginning of last year installed a plant for lighting the buildings and grounds. The plant runs about 125 sixteen-candle-power incandescent lamps and six eight-ampere arc lamps, which would call for a 9.6-kilowatt dynamo. Since, however, not all of the lamps are burning at the same time, a machine with an output of 8.25 kilowatts has been installed. This is driven from a line shaft by means of a friction clutch, the line shaft being driven through belts and gears by a single-cylinder horizontal slide-valve engine. There is also a storage battery of sixty cells and a capacity of 216 ampere-hours at a three-hour discharge rate, the maximum allowable rate being seventy-two amperes. Within the station all leads are run under the ground, consisting of lead-covered armored cable laid in asphalt. The end cell conductors in the battery room are heavy bare copper wires, supported on insulators and painted with an acid-resisting lacquer. The distributing mains are run both underground and overhead to the various buildings. The underground conductors are armored lead-sheathed cable laid in asphalt. The overhead conductors are carried upon poles of impregnated pine, eight metres long and twelve centimetres in diameter at the top. At all buildings where there is a danger from explosion or of corrosion from acid vapors, the wiring and lamps are kept on the outside. A special water-tight switch is placed on the outer wall, and the lamps are hung so as to shine in through the windows. The incandescent lamps are covered with an extra globe of stout glass, which, in turn, is protected by a wire guard. The arc lamps are used for lighting the roads and grounds, incandescent lamps being used wherever there is danger from explosion.

Automobile Testing.

The mechanical engineering department of the University of Illinois is conducting a series of tests upon an automobile furnished by the Packard Motor Car Company. From these tests the mechanical and commercial efficiency of the car will be determined.

The new 120-kilowatt Westinghouse polyphase generator, which was installed in the University power plant about six weeks ago, has been tested by the department of electrical engineering, full load being applied to the machine.

THE ELECTRODYNAMIC CONDENSER.

BY JAMES SWINBURNE.

In his recent presidential address, read before the British Institution of Electrical Engineers (see ELECTRICAL REVIEW, January 24), Mr. James Swinburne referred to the electromagnetic condensation. The following note, reprinted from the London *Electrician* for March 27, is in further explanation of the principle of this interesting apparatus.

The theory of this machine is very simple. There is a coil of wire suspended so as to be free to vibrate in a strong field. In the diagram, A, the field magnet, is made of soft steel, B is the exciting coil, and C the armature coil, held by weak springs tending to hold it half way up the circular gap, in the position shown.

The instantaneous pressure, E_i on the terminals must, neglecting resistance, be proportional to the number of "lines of induction" cutting the conductors, and therefore proportional to the speed at which the coil is moving. We thus have

$$E_i = k \frac{d x}{d t},$$

where k is the constant, and x is the distance which the coil has moved, and t is time.

The instantaneous current automatically sets itself to give the acceleration necessary to give the speed $d x/d t$ necessary to give the pressure E_i We therefore have

$$C_i = l \frac{d^2 x}{d t^2},$$

l being a constant. The current therefore varies as the rate of increase of the pressure, or

$$C_i = m \frac{d E_i}{d t},$$

where m is another constant. This is the equation of the current and pressure in the case of a condenser, so the machine acts as a condenser.

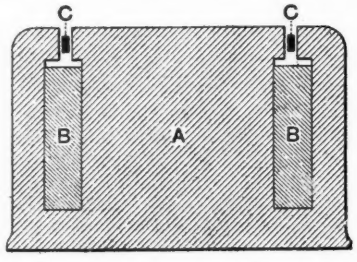
In these equations the constants involve B, the induction; so the equations are accurate only while the coil is in the field. Obviously, the current will become enormous if the coil comes out of the field-gap.

The principle is the same as that of a moving coil galvanometer with the coil suspended so as to be practically free to turn. I pointed out many years ago that such an instrument would act as a ballistic galvanometer or quantity meter. It will indicate either $\int E\,dt$ or Q (through a shunt) as long as they are within its range. If the coil is wound on a copper former it will measure Q without an external shunt. In the same way, a small motor whose armature runs freely would measure Q if it had a brake, but if it has none it will measure $\int E\,dt$, or if it has a circuit in shunt to its armature will measure Q. This kind of meter, with no revolving brake, is in commercial use. The O'Keefe meter is well known.

In order to get an idea of the size and output of an electromagnetic condenser a numerical example may be worked out. Let us take B at 16,000 C. G. S., frequency f at 50 periods per second, the stroke or amplitude of the coil as 4 cm., the number of turns n as twenty, and the total cross-section of copper as 1 sq. cm. The mass m of the copper, neglecting insulation, is then 1,410 grammes, the radius r being 25 cm. As the coil moves 8 cm. per period, and the frequency is 50, its mean velocity is 400 cm./sec. The mean electric pressure is then

$$E_{mean} = 10^{-8}\, 2\,\pi\, n\, r\, B \frac{d x}{d t} = 200 \text{ volts},$$

so the effective pressure is 200×1.11



$= 222$ volts, if the pressure varies harmonically.

As the acceleration is the rate of increase of the speed, and as the speed varies with the instantaneous pressure, if the instantaneous pressure varies as the sine of an angle, the current must vary as its cosine, so that there is a leading current, as in a condenser, and the acceleration, of course, varies harmonically, too.

The average speed of the coil is 400, so its maximum speed is $400 \frac{\pi}{2} = 630$ cm./sec., and it rises to this speed in quarter of a period, so that its mean acceleration is 126,000 cm./sec.^{2}. From the formula for the current,

$$C_i = 10\, m \frac{d^2 x}{d t} / 2\,\pi\, r\, n\, B,$$

we find the mean current is 35.25, and the effective current 39 amperes. The apparent power is thus 8,600 watts, and the armature loss about 2 per cent. Obviously the machine will not do for low frequencies. M. Leblanc has, however, used a dynamo or motor as a condenser for currents of very low frequencies. The principle is just the same. The dynamo machine runs backward and forward, of course, with no external load on it.

Washington, D. C., Branch of the A. I. E. E.

A branch of the American Institute of Electrical Engineers was organized in Washington, D. C., on April 9. After some preliminary discussion by members of the Institute residing in that city, a well attended meeting was held in the Columbian University, at which a permanent organization was effected and the following-named officers were elected: Chairman, Dr. Frank A. Wolff, professor of physics and electrical engineering, Columbian University; secretary, Mr. Philander Betts, electrical engineer, Potomac Electric Power Company; executive committee, Colonel Samuel Reber, U. S. A.; Mr. W. H. Tapley, electrician, Government Printing Office, and Mr. E. E. Clement, patent attorney and formerly chief examiner in the electrical division of the Patent Office.

After the election of officers and the transaction of other routine business, the following Institute papers were presented: "Interference Between Telephone and High-Tension Power Lines," by Paul M. Lincoln, read by Mr. Betts; "Burning of Wooden Pins," by C. C. Chesney, read by Mr. J. H. Finney; "Testing of the Insulators," by F. O. Blackwell, read by Professor Wolff. These subjects were generally discussed and much valuable information was elicited. Captain Edgar Russel, of the Army Signal Service, gave an interesting account of his experience with the insulation of telegraphs and telephone lines in the Philippines, where the most peculiar and serious difficulties encountered were the destruction of wooden pins by ants and the deterioration of the insulation caused by the nests of mud wasps.

President Needham, of Columbian University, has offered the new organization the use of one of the lecture halls in the college building, and monthly meetings will hereafter be held in that place. Among the Institute members residing in Washington are Dr. Alexander Graham Bell; George Westinghouse; Professor Cleveland Abbe, the original prophet of the Weather Bureau; Mr. U. N. Bethel, president of the Chesapeake & Potomac Telephone Company; Colonel Samuel Reber, Captain Edgar Russel and Lieutenant George O. Squier, of the United States Army; Captain Walter E. Chappell, United States Navy; Oscar T. Crosby and George C. Maynard, former vice-presidents of the Institute; Professor Edward B. Rosa, of the National Bureau of Standards; Professor Daniel W. Shea, of the Catholic University; Professor Wolff, of the Columbian University; Frank L. Freeman, Edward E. Clement, Philip Mauro, Joseph Lyons, Charles L. Sturtevant, electrical experts and patent attorneys; Mr. Walter C. Allen, electrical engineer of the District of Columbia; Mr. W. H. Tapley, electrician of the Government Printing Office; Louis D. Bliss, principal of the Bliss Electrical School, and Mr. Philander Betts, of the Potomac Electric Power Company.

THE DESIGNING OF TELEPHONE APPARATUS—XIX.

BY W. A. TAYLOR.

The number of kinds and the resistance of the various windings of relays are, of course, numerous, and according to the uses to be made of the piece of apparatus. The non-inductive relays, previously described, have their uses where it is essential to have a relay which permits the passage of telephonic currents and at the same time acts as an electromagnetic device. A modification of the non-inductive relay previously described, is shown in Fig. 53 in diagram. A, is the usual Norway iron core; C represents the winding, and B is a copper tube, fitting over the core. This tube acts in a similar way to the short-circuited winding, as previously described. It is, in truth, a winding of one turn. It is not necessary to have this tube insulated from the core, but the material, in order to give the best service, should be of copper. The voltage of the current induced in this tube is so low that any material resistance destroys the good effect. Such a relay as this acts slowly, both in pulling up the armature and in letting go. The time element is sometimes useful as it may act with an auxiliary relay to produce a circuit-effect which requires the auxiliary relay to act first.

Fig. 54 illustrates another form of winding in which there are two coils, A and B. This is the usual form of bridged relay used in the talking circuit. In order to retain the balance of the line the two coils are wound upon the relay and the battery so connected that a coil is interposed between each side of the line and the battery. This winding is used in a certain type with the difference that one winding is opposed to the other. When such is the case, a current passing through the two windings in series will not cause the armature to be attracted. The coil next to the armature must have a less number of turns than the other and there should be an iron shell over the spool. When the relay is excited one pole is at a point in the core designated by C, while the point D of the shell is the other pole. It would seem curious at first why the armature does not pull up at all times, and if it were not that there is a large air-gap between the poles C and D it would pull up. The lines of force due to the coil, B, flow more easily through the magnetic circuit by way of the armature and through the entire length of the core than through the air-gap between C and D; likewise the lines of force due to coil, A, more readily pass through the same path but in an opposite direction. There is, therefore, a neutralization, so that the armature does not act. The reason that coil B must be greater than A is because of the leakage of the lines of force. Part of them do not get far enough to operate the armature. This relay has the advantage of having a neutralizing winding which has a high impedance at all times. It is not possible

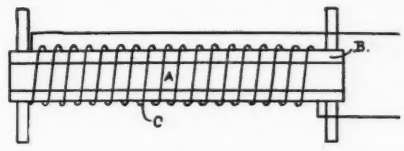


FIG. 53.

to design this relay to balance at all voltages. It is hardly possible for any voltage except that usual in central energy work. It should be wound strictly according to turns, as all relays having more than one winding should, especially if placed in the talking circuit.

Impedance Coils—It is frequently necessary in a circuit to introduce impedance when it is not necessary to have a relay or other apparatus. This impedance is merely a coil of wire with an iron core. The core, if solid, should be of soft Norway iron. Sometimes, however, the core is composed of soft iron wire like the core used in an induction coil. An iron shell should cover the coil entirely. This is for two reasons. With the iron shell the magnetic circuit is closed and a higher impedance is presented to the passage of alternating current. There is not any appreciable difference in the impedance of the coil to alternating current with a frequency as high as that of the voice when there is an open magnetic circuit, but there is quite

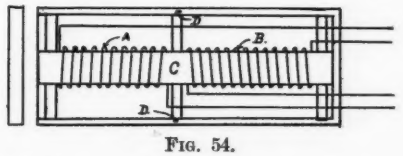


FIG. 54.

a difference when a low-frequency current passes, such as that of the ringing power. The main reason for the iron shell is to prevent electromagnetic induction to adjacent coils. Generally there is a number of impedance coils used where any is necessary, and as it is best to locate these close together there would be an immense amount of cross-talk in the system unless the coils were encased.

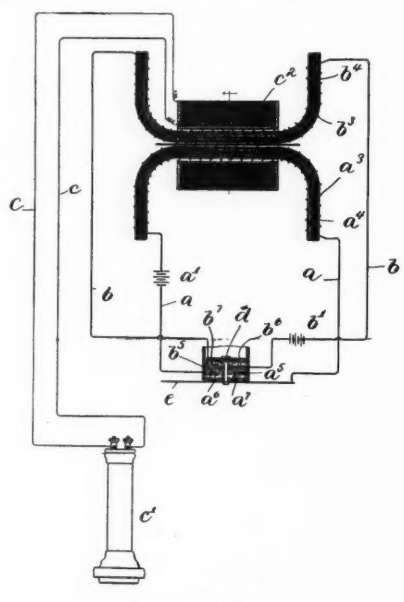
Lamps—The signal lamp of an exchange is one of the most particular points, as upon it depends the subscriber's ability to attract the operator's attention. The casual observer would not take much more notice of the signal lamp than he would of the average incandescent lamp used for illuminating purposes, except, perhaps, to comment upon its small size. There is one point necessary with this lamp which the other classes of incandescent lamps do not require, and that is they must be able to stand without injury a voltage greatly in excess of their normal rating. These lamps are lighted by the current from a storage battery, whose voltage will vary a great deal from the time it is freshly charged to the time it is ready to be charged again. Where there are ten cells of storage battery, the initial voltage may be as high as twenty-four, and the lowest voltage about eighteen. The lamp must then burn bright enough to be readily seen on the lower voltage, and it must be able to stand the higher voltage without quickly burning out. It took a number of years' experimenting before a really first-class switchboard lamp was made. Now, a good lamp should stand burning at full candle-power very nearly as long as any other lamp, and, at the same time, it will work nicely on the high voltage. With the short periods of use in the switchboard, a lamp will last for years before giving out.

The lamp commonly used in switchboards is rated at one-third candle-power and has a voltage as high as forty, and at any point under that, if desired. No doubt, if called upon to produce them, the manufacturer could turn them out at even higher voltage. It becomes more difficult to make these lamps as the voltage increases, because the filament must be made longer and finer. The average lamp is about one and one-fourth inches long and one-fourth inch in diameter, of cylindrical shape.

The switchboard of the manual type has now reached almost perfection, mechanically and electrically; whatever changes which may occur will be along the lines of the smaller details and in the rearrangement of the circuits. Where the discipline of the office is good, an almost perfect service is guaranteed. It remains to be seen whether any improvement will be made in the automatic switchboard. The problem of automatic service is great because of the great complexity and therefore great cost. If the numerous contacts can be made to work perfectly, and if the cost can be held within the bounds of reason, there should be a great future for it.

Electrical Patents.

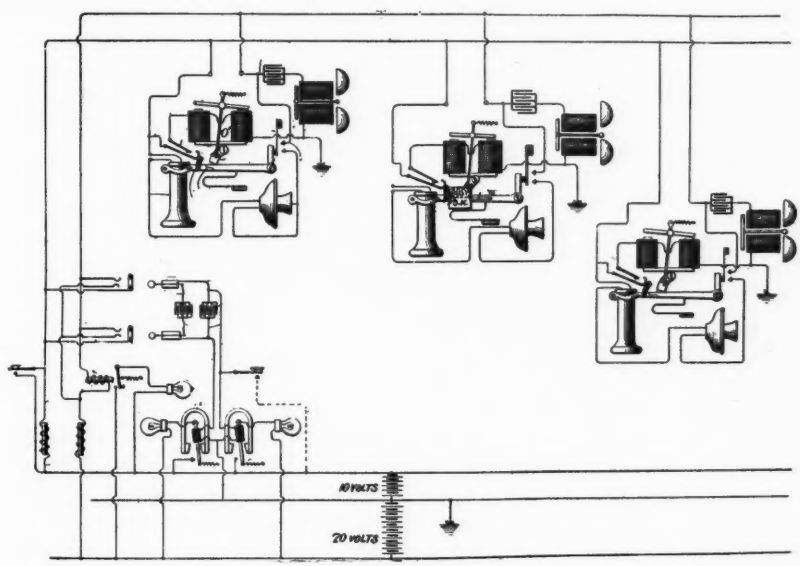
Mr. Albert L. Parcelle, of Boston, Mass., has obtained a patent on an induction coil, whereby means are provided that are acted upon by a plurality of circuits for effecting electrical impulses in a single circuit. Briefly stated, the invention consists of an induction coil, comprising two independent primary coils and a secondary coil common thereto, whereby the passage of a current of electricity through either of the primary coils will effect the electrical condition of the secondary coil. The illustration shows the invention when embodied in a telephone. The telephone has a receiver circuit including a secondary coil and two independent transmitter circuits, each having its primary coils in inductive relation to the said secondary coil. The transmitter circuits act to induce an alternating current in the receiver circuit, the initial direction of the alternations in the current caused by said transmitter circuits being opposite. This is achieved by employing transmitter circuits whose currents are of opposite polarity, or in the case of circuits having currents of the same polarity by winding the coils of the primaries in said circuits in different directions. By this construction and arrangement, together with the fact that the transmitters are so arranged that the variable resistance medium of one is compressed when the other is expanded, an increase in conductivity in one transmitter circuit is synchronous with the decrease in conductivity of the other transmitter circuit. It follows, therefore, that the current induced in the secondary coil by the collapse or waning of the current in one transmitter circuit is strengthened by the simultaneous induction of current in the same direction in said secondary coil by a current or increase in current in the other primary coil. The diaphragm upon which the sound waves impinge is connected with the movable members of the two transmitters, whereby the compression of the variable resistance medium in one transmitter will be synchronous with the expansion of said medium in the other transmitter. The effect of this is a much more faithful reproduction of pitch, loudness, and timbre or quality of vocal sounds than has hitherto been possible. In the cut, *a b* indicate two primary circuits, each shown as including a battery, a^1 b^1, respectively, although a single battery may be used if properly connected. The secondary circuit (indicated at *c*) includes the telephone receiver, c^1, and the secondary coil, c^2, made of fine wire in the usual way. The primary coils, a^3 b^3, are wound upon independent cores, a^4 b^4, respectively. Each core consists, preferably, of fine, soft iron wires, bunched together in a semi-circular form, covered with insulating material, the primary coils or windings extending well up the ends of the cores. The two flat sides of the cores and their enclosing coils, when well covered with insulation, are placed together, whereby the two cores approximate a cylinder. The ends of the cores project some distance beyond the spool of the secondary coil, and they diverge, whereby each core is substantially U-shaped to prevent material magnetic leakage. By virtue of the ends of the cores being widely separated, quick action in discharging is promoted, especially when a direct current is employed for exciting them; but it will be apparent that where the current in the primaries is alternating then the ends of the cores may be brought together to form a closed magnetic circuit. A double transmitter, or two oppositely acting microphones, is employed, as indicated somewhat conventionally. Two stationary members, a^5 b^5, properly insulated from each other, are used in conjunction with two movable members, a^6 b^6, rigidly connected together, as by the pin or screw, *d*. The members may be made of carbon or other conducting material. Between each stationary member and its coacting movable member is placed a variable resistance medium, a^7 b^7, as the case may be, such as granular carbon. The vibratory diaphragm, *e*, is connected rigidly to the member, a^6, of the pin or screw, *d*. Operation — Assuming that the diaphragm be moving inward, the variable resistance medium, a^7, will be compressed and that at b^7 expanded. The conductivity in circuit, *a*, will be increased, and a current flow from battery, a^1, through primary coil, a^3, around core, a^4. This induces a current in the secondary circuit, *c*, in the opposite direction by reason of the magnetic lines set up in core, a^4. As the diaphragm springs back by its inherent resiliency, the current in circuit, *a*, is weakened and the collapse of the magnetic lines of force in core, a^4, induces a change of current in the secondary, c^2, opposite to the initial direction. Synchronously with the collapse of said magnetic lines, the granules, b^7, are compressed, whereby a current flows from battery, b^1, through primary coil, b^3, in a direction opposite to the direction of the first mentioned current, through primary, a^3. Thereupon a current is induced in secondary coil, *c*, of the same direction and phase as that induced by the collapse of magnetic lines of force in core, a^4, so that the full strength and benefit of both batteries are obtained at the time most desirable. This operation is repeated for each vibration of the diaphragm. The two sources of electricity do not injure the microphones, or double transmitter, their effect and influence being on the secondary only of the induction coil. As they are both controlled by a single diaphragm, they are always in proper phase relation to each other, so that at the impingement of each sound wave upon the diaphragm the batteries are thrown upon the line in succession, so as not to interfere with or counteract each other.



Induction Coil.

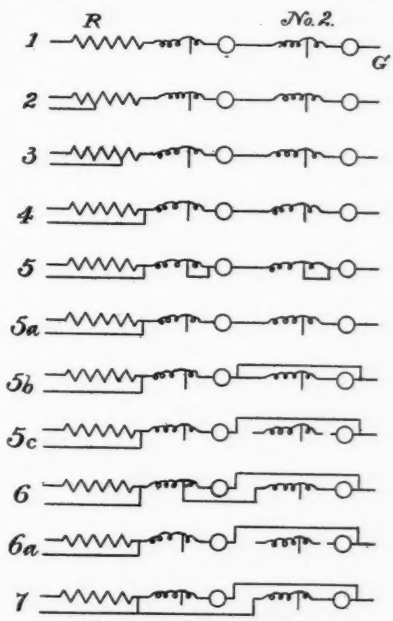
A lock-out party-line telephone system having some distinctly novel features has been devised by Messrs. Charles L. Goodrum and Jacob W. Lattig, both residents of Philadelphia, Pa. The invention has for its object the production of a party-line system such that when the line is in use by one party the other parties whose telephone sets are in connection therewith can neither "listen in" nor call central nor each other until the line be again idle. In the operation of the system an exception is provided for when it is desired to permit subscribers on the same line to converse. In such a case, specific action on the part of an operator at the central office or its equivalent is required, and in every case a call must first be made to the central office before communication can be had over the line. Such systems are usually designated "lock-out" party-line

systems, and this apparatus is designed to work with centralized or common battery. However, it can be adapted to other than common battery systems, and it will work equally well where selective or non-selective signaling is employed. The invention consists, essentially, in the employment at each subscriber's station of a mechanical lock for the switch, a polarized controlling magnet therefor having a biased armature normally set to locking position, together with means to connect this magnet to one side of the line in initiating a call, so that it will thereupon unlock the switch if the line is idle, but retain it locked if the line is busy. A source of energy is provided, connected across the line and divided in such fashion that normally the side of line above referred to will be at such a potential and receive such a polarity as to ensure the proper operation of the first locking device brought into connection with the line by a calling subscriber, but after such subscriber shall have secured possession of the line, the bridging of his telephone set there across will cause a reversal of the polarity, so that any locking devices thereafter brought into connection with the line will remain in locking position. When one party has called and thus obtained exclusive control of the line, if it is desired to permit another party to come in, means are employed whereby the polarity of current on the line may be momentarily reversed by the operator. As an incident to the operation of the locking apparatus, a visual indicator is actuated at each station to display the alternative indications of "busy" or "O. K." Any other desired legends may be substituted for these, or the indicator may be dispensed with.



LOCK-OUT PARTY-LINE TELEPHONE SYSTEM.

The patent on an electric controller invented by Mr. Frank A. Merrick, of Johnstown, Pa., has been purchased by the Westinghouse Electric and Manufacturing Company. This electric controller is thus described by Mr. Merrick. My invention relates to the control of series-wound electric motors; and its object is to provide a controller therefore that will accelerate the motors and regulate their speed in a simple and efficient manner. The controller that I have provided is one of the general class known as "series-parallel controllers," which are more usually used to control electric railway motors. My improvement consists in the construction and arrangement I employ, by which certain novel steps or series of steps are provided to accelerate or regulate the motors at speeds higher than that obtained by placing the two motors, as units, electrically in series with each other. More particularly, these novel steps or series of steps constitute an advantageous way of changing two such motors from series to multiple in such a way that even though no external resistance be used the motors are not subject to abnormal rushes of current or dangerous inductive efforts. Morever, I am enabled to make this change without disrupting the main circuit and subjecting the controller to heavy sparking. In addition, in changing from series to parallel the intermediate speeds provided are such as to accelerate gradually and also to allow of positions at which the controller may rest for a considerable time to give a desired speed without injury to the motors. To these ends I connect to the controller a point on each field winding intermediate to its terminals and arrange the contacts on the controller, as hereinafter set out, in such a way that at appropriate positions I can effect a short-circuit around a part of each field winding to provide safe positions in which the speed is increased by the weakening of the field magnet thus caused. I also so arrange the controller contacts and the connections therefrom to the motors whereby I may place one motor in parallel with the armature and a portion of the field winding of the other motor, the remaining portions of such field winding being in series with the two branch circuits, and therefore receiving the current of the whole circuit. This novel step I have found to be an extremely advantageous one, the motors dividing the work well without taking an unsafe current. The two steps here suggested are advantageously used together, for they can be made to give a nicely graded acceleration from a position in which the two motors, as units, are in series with each other to a position in which the two motors, as units, are in parallel with each other. The invention also relates to certain other combinations of contacts and connections which enable



ELECTRIC CONTROLLERS.

me to efficiently change the connections from one step to another. In the more specific application of my invention the part of the field winding shunted by the controller at certain steps represents the entire winding of one or more of the field magnet poles. Thus in a four-pole motor I have shunted the winding of one pole. This pole therefore becomes a consequent pole during such time as its winding is short-circuited, and I have found that this arrangement is attended with excellent results. An additional advantage of my invention is that I am enabled to provide a very simple arrangement of controller-contacts and one that may be cheaply constructed.

Reviews of Current Engineering and Scientific Literature.

The Use of the Small Electric Motor.

Mr. Frederick M. Kimball here gives a brief historical sketch of electric motors, and traces their development from the earliest type to the standard motor of to-day. The advance within the last ten years has been more remarkable than that which preceded it, and one can hardly mention any piece of apparatus of the size and weight which is sold for the price, and which embodies the results of more painstaking work on the part of designing engineers, and the expenditure of more money on experimental work, than the small motor of the present day. The advantages of the motor-drive are discussed, the point being made that the tendency at present is to locate new factories on the outskirts of the cities. This generally calls for the induction motor, but direct-current motors will be used for many years for power purposes within the district lying not far from the central station. When one considers the enormous amount of power generated and distributed for manufacturing purposes in the United States, and then remembers that probably less than seven per cent of all this power is distributed electrically, some idea may be formed of the possibilities yet unrealized by the use of electric motors. It is estimated that there are at the present time not less than 60,000 motors in use, exclusive of those used for railways, automobiles, fans and elevators, supplying something like 1,000,000 horse-power, and representing an investment of $12,000,000. The advantages of the electric motor for machine driving are pointed out, and it is said that there is no problem of more vital interest to the small manufacturer than that of obtaining a reliable, simple and continuous source of power. This question frequently causes the location of factories in out-of-the-way, badly ventilated and badly lighted shops. This could be avoided by adopting a motor-drive. The electric drive is, furthermore, economical because the user pays for only the power consumed. Another advantage is that by introducing indicating instruments the superintendent can frequently detect an excess use of power, and thus locate a badly working machine. This is a valuable feature of electric driving, as it often discovers the abuse of lathes and other machines by the piece-workers having care of them. The final results of all these desirable features of the use of motors are increased output, lower cost, higher quality of product, and larger profits.—*Abstracted from the Engineering Magazine (New York), April.*

The Lodge-Muirhead Wireless Telegraph System.

In this article Mr. H. C. Marillier gives an account of the claims made for the Lodge-Muirhead wireless telegraph system, and describes the apparatus used. The system has been tried extensively under sea-going conditions, between a temporary station, near Holyhead, and one of the Johnston Line steamers, covering a distance of sixty-two miles. The test was so successful that the inventors now feel justified in offering it for commercial purposes as a practical working system. Distance has not been especially aimed at, more attention having been paid to securing clearness and accuracy. The fundamental patents on which the Lodge-Muirhead system depends were taken out in 1897, and provide for the following essentials: The combination in transmitting and receiving circuits of two capacity areas and an inductance coil is a vital element in a syntonic system of wireless telegraphy. The capacity areas may be regarded as the two coats of a Leyden jar spread out in space. Between them is situated the spark-gap. Between the spark-gap and the lower capacity is the inductance coil, as well as the condenser, both being adjustable. Sir Oliver Lodge's main idea in transmission has always been to obtain a succession of waves of definite frequency, the accumulative influence of which would produce a perceptible effect upon a suitably tuned receiver, no matter how feeble the waves might be. The second point claimed by the inventors is the use of a transformer or ironless induction coil in the receiving circuit. The claims also cover the use of a condenser shunt in the coherer circuit, such as will enable that circuit to have a definite time period. The new coherer, of which an illustration is given, consists of a small steel disc, just separated from a column of mercury by a film of mineral oil. This is rotated slowly, the oil serving as an insulating layer until broken through by an electric wave. Contact to the disc is made by means of a copper brush pressing upon the axle, while a steel spring tipped with felt rests upon the edge of the disc and keeps it clean. The coherer is placed directly in circuit with a siphon recorder, without the interposition of any relay, and is connected also with a potentiometer for the purpose of regulating the difference of potential at its terminals from 0.03 to 0.5 volt. The signaling apparatus consists of a specialized Morse key, worked by hand; or, what is a distinctive feature of Dr. Muirhead's improvements, an automatic signaling machine, used in conjunction with a perforator of special pattern. In either case, the local signaling circuit contains a transmitter designed to open and close contact at a definite rate the primary of the induction coil. This instrument is made up of two telegraphic sounders, cross-connected in such a way as to act reciprocally. An aluminum arm, fitted with a copper rod dipping into mercury, is attached to the armature of the second sounder, and the rapid make and break between the copper rod and the mercury—about 600 times per minute—serves to fix the frequency of the sparks. The function of this apparatus is to cut up the long-continued contact of the Morse key into a rapid succession of sparks. If the rapidity of the sparks is insufficiently great, the signal, as recorded by the siphon recorder, becomes a broken or wavy line. The new coherer, in combination with a recorder, follows every fluctuation and peculiarity of the received waves, and indicates any inequality and uncertainty which may occur in the sparking transmitter.—*Abstracted from the Electrician (London), March 27.*

The Schuckert Surface Contact System.

This system was first tried in Munich, from October, 1898, to February, 1899, at night, after the ordinary service had ceased. These trials proving satisfactory, permission was granted for trials to be carried out in the daytime, from February to November, 1899. As everything was still found to operate in a thoroughly reliable manner, the section was taken into ordinary service, of which it formed a part until October, 1901. The system will probably be tested in England on a relatively large scale. This article gives a complete description of the system, including recent improvements. The automatic switches are arranged in groups of thirty, spaced about 300 feet apart, the contact studs being spaced about ten feet. The switch apparatus is fixed in

distributing boxes before leaving the factory. The boxes are erected complete, and are water-tight. The method of operation is as follows: When the current collector of the motor car touches the contact studs, a small current passes through an electromagnet, closing the circuit between the feeder and the contact stud. As the collector leaves the stud a current is sent through a second electromagnet, which opens the circuit. The four coils of these two magnets are arranged in a parallelogram, and the armature which operates the contact arm is pivoted centrally between them. It can then swing into line with either diagonal. The magnetic force by which the switch is operated is so great as to exclude the possibility of contact sticking, and the only moving part of the switch is arranged in such a position that it can not touch or catch on any of the non-moving parts. The pivot is loose in its bearings. The contact plugs are of carbon. During the trial working of the system in Munich, no switch proved defective, and not a single carbon contact was changed. Special tests have been made in order to form an opinion as to the mechanical wear of the switches on lines with heavy traffic. By means of a motor-driven switching device a number of these contacts were operated, working 8,000 times a day during six months. This period of work corresponds to an ordinary use of seven years, on an eighteen-hour service of cars passing every two minutes. The armature, with its carbon contact, was not subject to any appreciable wear during the test. The magnet coils are arranged in circuit so that there is a difference of but twenty-five volts potential on each coil; and a breakdown, due to defective insulation, is practically impossible. The current-collecting device consists of a linked chain, either end of which is attached to the point of the rail guards by means of a spiral spring and adjusting screw. The chain is suspended the full length of the car by a number of spiral springs. The collector is noiseless in operation, adapts itself to all unevenness of the track, and permits the use of studs projecting but slightly above the pavement. When the current collector momentarily fails to act, and thus does not close the contact switch, the arrangement is so devised that the motors are connected as generators, when the electric brake is brought into operation, and are thus used to excite the contact studs. This excitation of the contact studs takes place even when the car is moving very slowly, but only when the motor circuit is broken with the car under way. When the car is standing still, a small hand generator is used for this purpose. This is placed under the car seat, and is so geared that one turn of the crank is sufficient to operate it. It takes the place of the usual storage battery equipment required by other contact systems. A series of curves is given, showing the current consumption of a car in actual operation and under various conditions.—*Abstracted from the Tramway and Railway World (London), March 12, and Engineering (London), March 27.*

High-Tension Switching on a Heroic Scale.

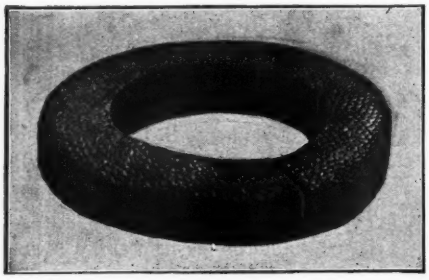
In this article are given some of the details of the high-tension switching devices adopted by the Butte Lighting and Power Company, of Butte, Mont., in the receiving station in the city named. This system was designed to operate at 80,000 volts, although up to the present time it has been possible to supply the full demand for power at 40,000 volts. The line is supported on No. 1 Provo type glass insulators, having a diameter of seven inches across the bell. There are four transformers of 330 kilowatts each, built by the General Electric Company, which transform this pressure from 80,000 or 40,000 in star connection on the high side, to 2,200 in three-phase current for the local lighting and power circuits. Previous to filling the transformer case with oil, it was exhausted of air and the winding heated to expel any moisture which might be on the surface of the coils; and while in this vacuous condition, the oil was allowed to flow in. Insulation tests were made with the transformer at 160,000 volts, but failed to develop any weakness. Tests were also made to detect dielectric hysteresis losses. The transformers were excited at double their normal voltage on their low-potential side, and the losses were then measured with the high-potential windings separated into several sections, so that the maximum voltage generated was so low that no such losses could take place. The high-potential windings were then connected in series, and the losses again measured, and they were found to be identical with those first observed, thus indicating an entire absence of dielectric hysteresis losses. The terminal cables have soft rubber discs projecting from them. This construction was necessary in order to break up the static charges which took place over the surface of the insulations when the transformers were under a strain of 100,000 volts between the windings and ground. The line wires, which are six in number, enter the building through the rear or easterly end, by means of high-tension plate-glass bushings. A wooden casing contains a piece of plate-glass which is thirty inches square and one-quarter of an inch in thickness. Two such casings and glass plates are set into the brick wall of the station. In the centre of each glass plate is cut a hole approximately four inches in diameter, into which is set a Provo No. 2 glass insulator from which the top has been broken off. The bells of these insulators flare outwardly, and a glass tube is inserted into the openings that have been cut axially through the centres of the insulators. The wires run loosely through these window tubes, but are supported on pins and insulators placed beyond and without the point of passage. From the glass bushings the lines are carried down through one-quarter inch piping supported on standard insulators, to a sliding contact which rubs against a copper rod five feet in length, which is secured to a wooden framework through standard insulators. This rod forms the clip of the first high-tension break switch, for its point closes into a stationary socket which forms the terminal of a similar rod two feet in length, from the further end of which is suspended a high-tension fuse. The fuses used are of standard aluminum five feet in length, and covered with a thick woven tube of fibrous material, well impregnated with fireproof compounds. In line with these rods is a second stationary socket, immediately after which is a high-tension break, similar in construction to the first, but having a length of eleven feet six inches; and upon the second sliding rod the sliding contact bears which carries current to the transformer. The heaviest arc that has been drawn out through the pulling of the switch has been broken by the upward movement of the arc before the switch terminals have been separated three feet. This marks the performance of the switch in carrying 100,000 horse-power at 40,000 volts. When the switch is opened slowly at a pressure of 40,000 volts, while the transformers are excited, but are carrying no load, the arc waves up in a ragged, inverted V-shape until the switch points have been separated ten or twelve inches, when it breaks. With the ten-foot switch open and no capacity beyond the smaller switch, except that of the fuse and four feet of switch rods, the arc will hang on in a thin thread until a separation of three or four inches causes it to break. The lightning arresters possess no unusual features, being of the ordinary Wirt type.—*Abstracted from the Journal of Electricity, Power and Gas (San Francisco), March.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Asbestos High-Pressure Packing Rings.

The accompanying illustration is a reproduction of a photograph of an asbestos high-pressure packing ring which was removed from the stuffing box at the steam end of a Worthington duplex compound steam pump. This packing had been in constant use for six years, without causing the engineer the slightest trouble, and was in such condition as to permit of further efficient service. The



ASBESTOS HIGH-PRESSURE PACKING RING.

rod is still perfectly smooth. This packing has been working continuously under 125 pounds pressure, the pump capacity being 3,000,000 gallons every twenty-four hours. This packing is manufactured by the H. W. Johns-Manville Company, 100 William street, New York city.

The Angulator.

From time to time it becomes evident that disinterested parties favor a method of determining the real value of an incandescent lamp as a source of light, by calculating the spherical candle-power of the lamp, and considering this in

FIG. 1.—THE ANGULATOR.

connection with the actual current required to operate it, in preference to measuring the illuminating value of the lamp, based on the horizontal intensity of the rays of light.

One of the arguments, however, against rating lamps by their spherical candle-power is that the apparatus for securing a correct result is delicate and of high cost for proper construction. It is also necessary to determine the spherical candle-power to take numerous readings, which require considerable time, and this is viewed with more or less disfavor from a commercial standpoint.

Professor C. P. Matthews, of Purdue University, is among the number who have devoted considerable time to the solving of this important question. Professor Matthews has invented a very satisfactory apparatus for determining the spherical candle-power at a single reading. Professor Sharp, of Cornell University, has also devoted much time to the solving of the problem, and has prepared a method of calculating the spherical candle-power of lamps having various forms of carbon. Professor Sharp's method consists of determining the mean horizontal candle-power in the regular manner, and then making one measurement

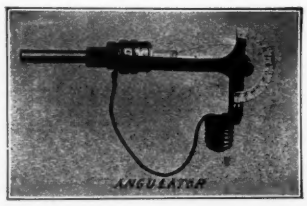


FIG. 2.—THE ANGULATOR.

through the tipped end of the lamp, multiplying the mean horizontal candle-power by 0.8 and the tipped end measurement by 0.3. The sum of the two results would be very close to the real spherical candle-power of the lamp.

The Shelby Lamp Company, of Shelby, Ohio, is now placing on the market an angulating device which readily fits into the socket of any standard photometer. One view of this device is shown in Fig. 1. By the aid of this apparatus the horizontal candle-power can be determined, and the lamp can then be turned so that the light may be measured at any angle, as shown in Fig. 2. One of the strongest claims of the Shelby company for its incandescent lamps is in the construction of the filament, which is so designed that the greatest amount of light is delivered through the end opposite the base of the lamp, and at an angle of forty-five degrees thereto. This angulator has been designed with a view of placing at the disposal of every owner of a photometer a method of determining the value of his lamps, regardless of whether the lamp is used for general illumination or for local illumination. The value of the lamp used for general illumination can only be determined by considering the light emitted in all directions, and it is claimed that the light used for local illumination should be delivered through the end of the lamp opposite the base.

New Type 220-Volt Lamp.

The Standard Electrical Manufacturing Company, of Niles, Ohio, is placing on the market a new type of 220-volt lamp. This lamp, the manufacturer claims, possesses features of great practical value. The manufacture of the ordinary type

NEW TYPE 220-VOLT LAMP.

of 220-volt lamp presents some mechanical difficulties which the lamp-maker has expended many efforts to overcome. If the filament is made long enough to allow of any treatment, there is difficulty in securely anchoring it, due to the liability of the coils jarring together; and at the same time, if a filament is made short enough to be rigid, the resistance is considerably reduced. The question of using untreated filaments is more or less open, and it is often stated that filaments can be made of such superior quality that they will give fairly good results without

further increasing their density by the deposit of carbon upon them.

The advantage claimed for this new type of 220-volt lamp is that before treatment the filament has a cold resistance of approximately 2,400 ohms. This allows the resistance to be decreased to about 1,600 ohms by the ordinary methods employed in the 110-volt lamps; that is, by depositing graphitic carbon in its densest shape on the filament, thus ensuring after given efficiency practically the same curve for the maintenance of candle-power that the 110-volt lamps show. The Standard Electrical Manufacturing Company claims that with this lamp, containing the treated filament, a three and one-half watt, 220-volt lamp is perfectly feasible, and that it will also be possible to produce, without any great difficulty, a satisfactory lamp of as high a voltage as 300.

Electric Vehicles.

The accompanying illustrations show two types of electric vehicles manufactured by the Buffalo Electric Carriage Company, Buffalo, N. Y.

Fig. 1 shows the Buffalo stanhope, which is built for all classes of service as a pleasure vehicle. The front axle is of steel, one and one-quarter inches in diameter, the back axle being one and three-quarter inches in diameter. Four elliptic springs ensure easy riding, and the machine is constructed with ball-bearings throughout. The wheels are entirely of wood, with solid rubber tires. The tires are one and three-quarter inches in front, and two inches in back. The reaches are made of a fine quality of hickory, and the body panels of thoroughly seasoned wood of a nature which obviates any danger of cracking. The seat is forty-one inches wide, giving ample room for two persons. The style of top is the Victoria design, and is of leather, with leather on the fenders and dasher. The upholstering and carriage fittings are of the latest carriage design, and the aim is made to make this feature very satisfactory. The equipment consists of one two and one-half horse-power motor, which, it is claimed, will develop ten horse-power for a period of five minutes, if required; also one electric brake in the motor, and one double friction brake, capable of stopping the vehicle when going at full speed, within fifteen feet. The battery consists of forty cells, giving eighty volts, with a capacity of four hours on discharge with the highest rate of speed on the level. This is claimed to ensure fifty miles on one charge on fairly level streets. The controller gives six forward speeds and four backward speeds. The highest speed is seventeen miles per hour.

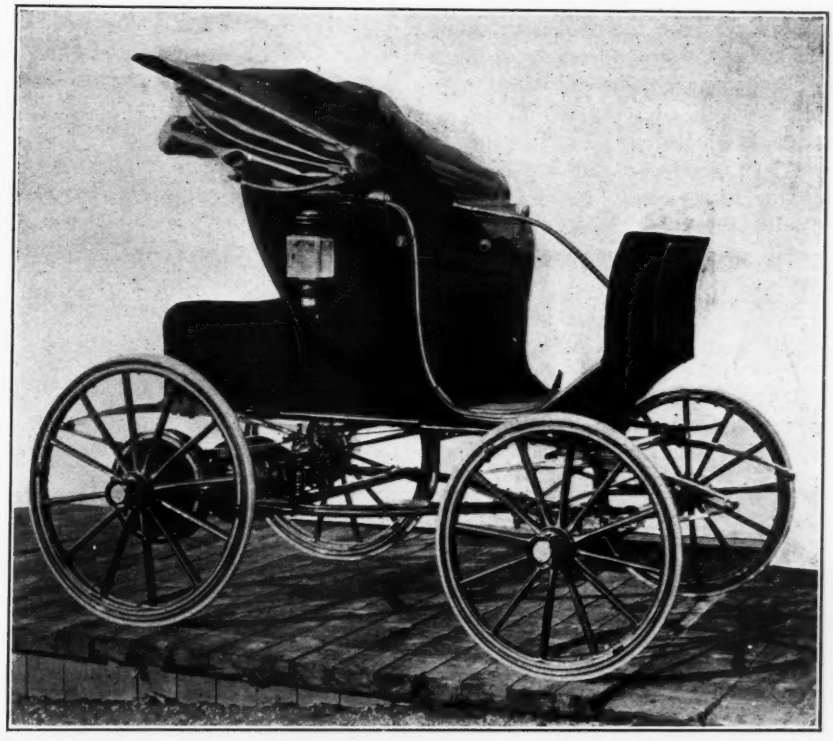


FIG. 1.—BUFFALO ELECTRIC STANHOPE.

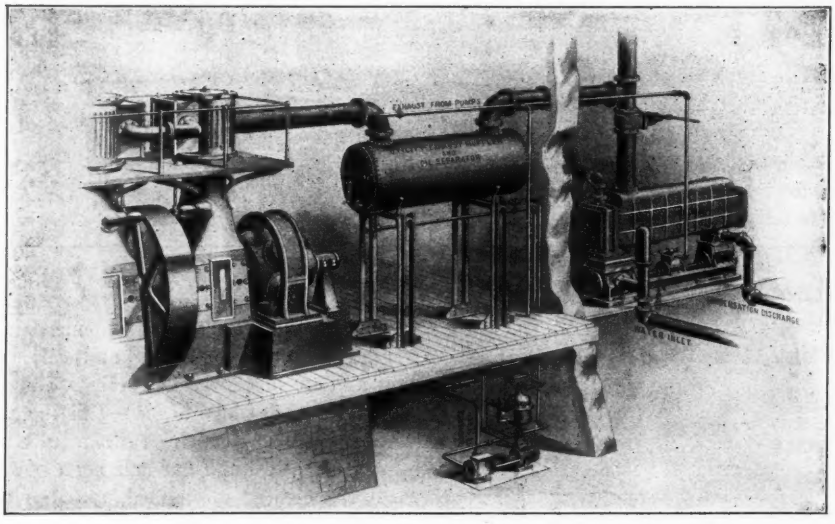
FIG. 2.—BUFFALO ELECTRIC GOLF BRAKE.

Fig. 2 shows the electric golf brake manufactured by this company. The construction is very much the same as the stanhope, with the exception that two motors are used instead of one, with heavier springs and axles. The seats are wide and comfortable for three grown persons on each seat. This machine has six speeds, the highest being about seventeen miles an hour, and, it is stated, will make fifty miles on a single charge.

A Test of an Oil Separator.

A great deal of trouble has been experienced by the users of steam apparatus, due to the presence of cylinder oil in the water from the condenser. Many elaborate and expensive systems of filters for filtering the condensed water, combined with an oil separator in the exhaust between the engine and condenser, have been developed and worked with more or less success. Because of this difficulty there has been a somewhat popular use of jet condensers in both large and small plants.

In the accompanying engraving is shown the "Utility" oil separator. This separator has been on the market since 1898, and is now installed in many representative steam plants. The manufacturer claims that it will clean the steam so that all exhaust condensation can be returned without injury to the boiler. Chemical tests of the condensed water under analysis, it is stated, have shown that where these separators have been doing service for years, the water has been rendered perfectly applicable for renewed use in the boiler.



OIL SEPARATOR, CONNECTED BETWEEN ENGINE AND CONDENSERS.

On March 24, 1903, a test was made by Professor F. R. Hutton, a member of the Society of Mechanical Engineers, on a "Utility" oil separator connected between an engine and condenser. In this installation a standard size of separator was used for a twelve-inch exhaust pipe, the separator being forty inches in diameter and ninety-six inches long. The space between the nozzles—sixty inches—was filled with a series of baffling or separating plates, made with iron chains suspended in a semi-circular frame. Under the temperature the oil and water arrested by the chains must drip to the pump governor, as shown in the figure, and are then pumped to the sewer. Referring again to this test, the engine was a 250-horse-power Ball engine at the Brooklyn Navy Yard. Two tests were made. In the first, a half pint of oil was sent through the lubricator of the engine during an hour's run, and in the second test an entire pint was used and passed through the engine in the same time. The "Utility" separator was connected between the engine and a surface condenser, and by means of pumps, samples of water containing the oil separated from the exhaust steam were taken from the separator; and samples of the condensed water were taken from the condenser after the separation of the oil.

By comparing the amount of oil in the sample with the amount of oil which passed through the engine, and the total weight of water condensed and water withdrawn from the separator, the result showed that in the first test ninety per cent of the oil was caught in the separator, and that of the mixture of water and oil issuing from the condenser, only 0.0008 per cent was oil.

This separator is manufactured and sold by the Standard Steam Specialty Company, New York city.

The Calculagraph.

In the accompanying illustration is shown a calculagraph, and the same machine mounted in the toll desk of a toll line switchboard. This apparatus is designed so that the visual and manual operation of noting elapsed time and computing the cost of such is done automatically by a single operation.

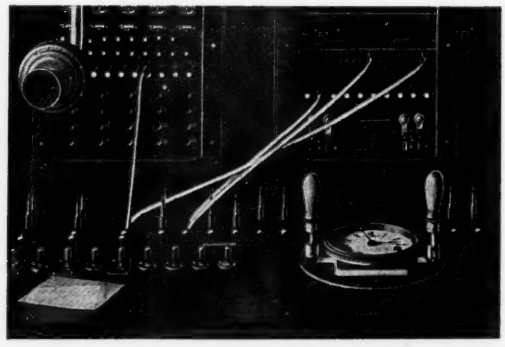
This machine mechanically subtracts the time of commencing from the time of finishing, and prints the difference—the elapsed time—in hours and minutes. This machine requires no skill to operate,

CALCULAGRAPH.

a card being pushed into a slot and a lever being pulled down.

The number of calculations a single instrument is capable of making is only limited by the number of cards it is possible to push consecutively into the slot during a given time.

Special calculagraphs are made for use in particular industries. The one shown in the accompanying illustration is for timing conversations held over telephone toll lines where the charge for service is based on the length of time a circuit is used. In this case instruments are provided which record the elapsed time in minutes and quarter minutes. These machines are now in use in a number of telephone exchanges in the United States,



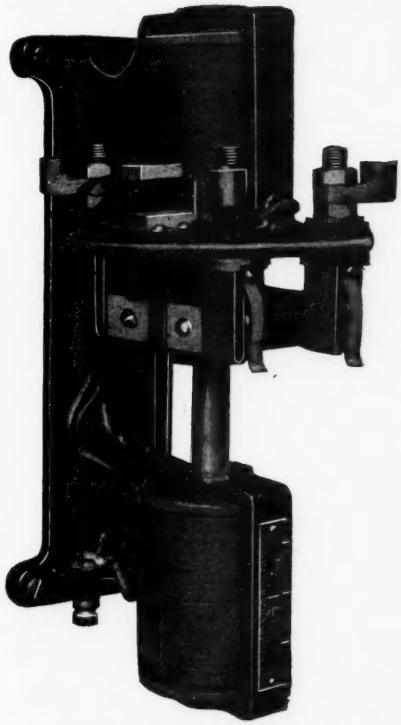
CALCULAGRAPH MOUNTED IN TELEPHONE SWITCHBOARD.

and the manufacturer claims that wherever a trial has been given the satisfaction has been complete.

This machine is made by the Calculagraph Company, 9 to 13 Maiden lane, New York city.

Automatic Switches.

In the accompanying illustration is shown a type of automatic switch manufactured by the General Incandescent Arc Light Company, New York city, which the maker claims possesses several features which make it a valuable addition to this field. These switches are made either one, two or three-pole, for service on voltages up to and including 250 volts, and to carry currents up to 200 amperes. The demand, however, for switches of larger sizes has necessitated the design of larger capacity apparatus for these voltages, and this company has now installed automatic switches which are designed to continuously carry as much as 2,500 to 3,000 amperes. The design for the larger size switches is different from that of the smaller ones, and they are made so that the amount of current



AUTOMATIC SWITCH.

which can be handled is not limited within any commercial requirement.

The switches of the smaller size are made to meet the condition where it is desired to cut out the entire lighting system of a building or house by simply pushing a button from one or more distant points.

These automatic switches are built on an iron frame in a strong and substantial manner, and at the same time produce a strong magnetic field for the operating solenoids. These switches are intended for installing in a vertical position, so that gravity tends to open them, and the opening of the switch is accomplished by a hammer blow produced by a core in the lower solenoid, having a lost motion which is first taken up before the burden of opening the switch is thrown upon it. This ensures the switch opening at all times, a large factor of safety being introduced in this manner.

Motor Starting Rheostats.

The "Wood" automatic double-release motor starting rheostat, circuit-breaker and switch, combined, is designed to protect the motor at all times from overloads or other unnatural conditions. These dangers result from different causes. At

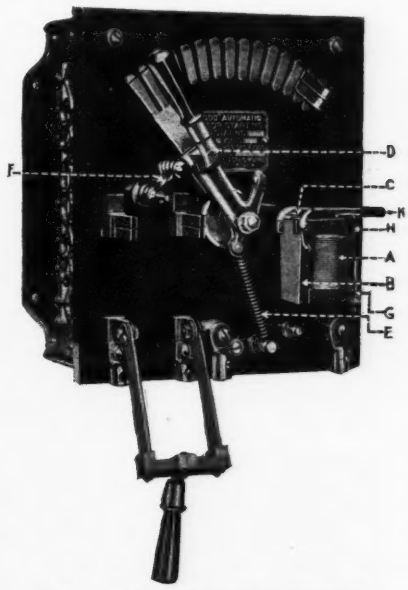


FIG. 1.—MOTOR STARTING RHEOSTAT.

times there is a possibility of an excess rush of current to the motor armature in starting; at other times too much work is put upon the motor, and a further cause is that at some time the main switch on the power line feeding the circuits to the motor may be accidentally opened and then

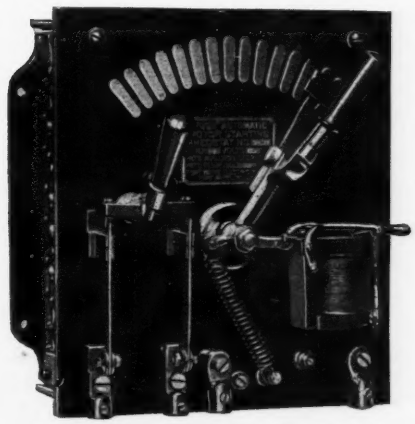


FIG. 2.—MOTOR STARTING RHEOSTAT IN RUNNING POSITION.

thrown on the line while the motor is still in the emergency condition.

In this apparatus is combined a circuit-switch, a circuit-breaker which takes the place of motor fuses or a separate circuit-breaker, and a no-voltage release and an overload release. The operation of this combination of devices is simple. In starting the motor the double-pole switch is closed and held by a spring catch. The apparatus is shown in the accompanying illustrations—Fig. 1 and Fig. 2. Referring to Fig. 1, the handle, D, is moved over the contacts, cutting out the resistance until normal speed is attained, at which point the resistance is all out. The handle is held in this position by a locking latch, C, on the upper part of the arm, B, of the double-wound solenoid, A. This solenoid has two windings, one carrying the motor armature current, and the other carrying the motor field current. The function of the field coil is to hold the lower end of the armature against the lower part of the solenoid. A decrease in the line voltage reduces the current in the motor field, weakens the solenoid magnet, and allows the lower end of the armature to recede from the solenoid, releasing the catch on the arm from the upper end of the armature. The spring, E, swings the arm across the contacts, cutting in the resistance, striking the circuit-breaker attachment, F, and tripping the catch which holds the double-pole switch closed, allowing the spring to throw it open, thus opening the circuit. A heavy current in the motor armature, due to an overload, causes the upper part of the solenoid to attract the upper part of the armature, releases the rheostat arm, and opens the circuit after inserting all the resistance of the rheostat.

The solenoid is ordinarily adjusted to open the circuit when the current exceeds normal full load value, or may be adjusted to operate at any desired load or overload by altering the tension of the spring, H, acting on the solenoid lever arm and opposing the pull of the magnet.

The motor may be stopped by raising the small handle, K, attached to the armature lever, thus releasing the rheostat arm and opening the switch. This method of stopping a motor has the advantage of throwing in circuit all the resistance before the armature circuit is opened, thus reducing to a minimum the armature current and the resultant reactive effect of the motor field coils, which is pronounced on high-voltage circuits.

The construction of the rheostat is fireproof throughout. An iron frame lined with asbestos supports the resistance coils mounted on porcelain, and the front of the rheostat is enameled slate. The operation of the circuit-breaker produces no arcing, and there are no relays with arcing contact points.

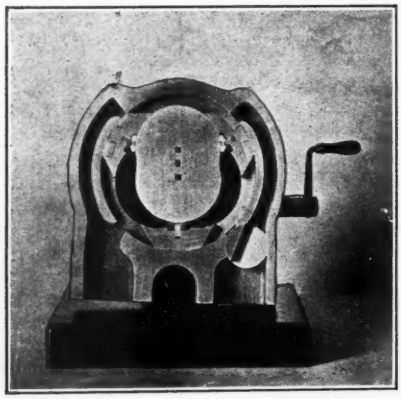
These rheostats are standardized in ten sizes, from one-quarter to fifty horsepower, and for standard motor voltages of 115, 230 and 500 volts, and are of rigid construction. The arrangement of the resistance coils is compact and neat, and the rheostats are furnished with base flanges for mounting on wall or post by means of lag screws or bolts. These rheostats are manufactured by the Fort Wayne Electric Works, Fort Wayne, Ind.

An Epicycloidal Engine.

A public demonstration was made recently of the operation of a new rotary engine which is manufactured by the Cooley Epicycloidal Engine Company, of Alliston, Boston, Mass. At the same time, the instruments and machines manufactured by this company were placed on exhibition.

A model of one form of this engine is shown in the accompanying illustration. It consists of a bicuspid formed piston, revolving within a tricuspid formed spacer, this spacer also revolving within a cylinder in the same direction as the piston, but at a different speed, the ratio being three revolutions of the piston to two of the spacer.

These engines have a surprisingly large output for their size. The first engine constructed was seventeen inches long, seven inches wide, and seven inches high. Under test it developed about twelve horse-power, with a consumption of steam between forty and forty-three pounds per horse-power-hour. A ten-horse-power engine and air compressor set was shown operating a pneumatic hammer. This set consists of two engines, one operating as a motor and the other as the air pump. Each machine measured actually fourteen inches long by six and one-half inches high, and five inches in width, weighing forty-five pounds, and revolving at the rate of 2,000 turns per minute. A single engine of this type was shown in another part of the testing room, directly connected with a propeller operating in a tank of



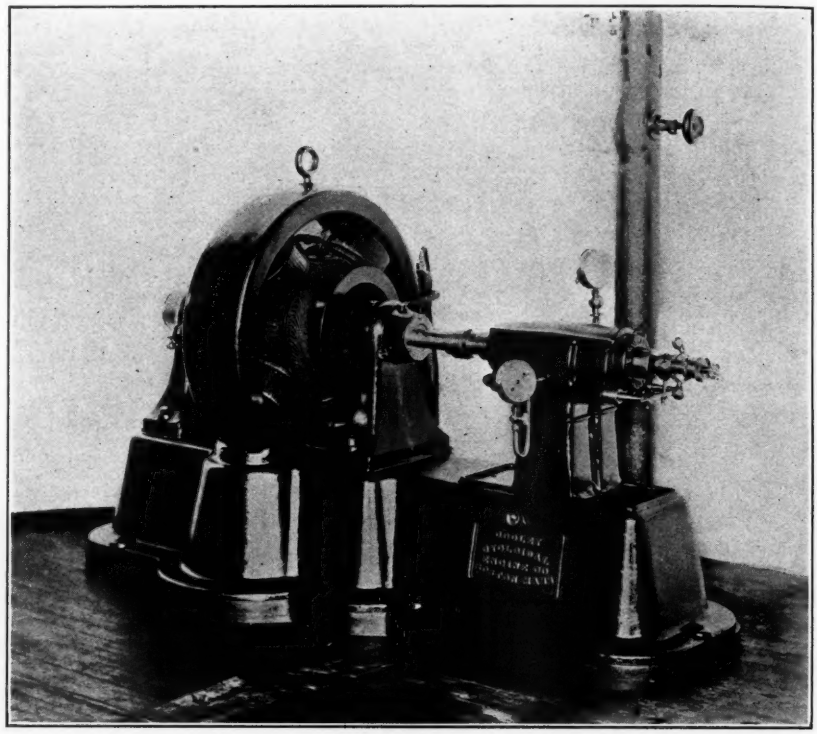
Model of the Rotary Engine.

water. The engine could be started and reversed under full head of steam without any damage.

A seventy-horse-power engine was also shown at work driving the shops. This engine has been tested by Professor Edward F. Miller, of the Massachusetts Institute of Technology, and has made a very creditable showing. The results of this test are given in the accompanying table. This engine is of the single-cylinder, belted, jacketed type, fitted with a throttling governor. At low outputs of three to four horse-power it consumes about sixty pounds of steam per horse-power-hour; but this falls rapidly, until at twenty-horse-power output the steam consumption is but thirty-three and one-half pounds per horse-power-hour. This falls again to thirty-two and seven-tenths pounds when the output is twenty-four horse-power.

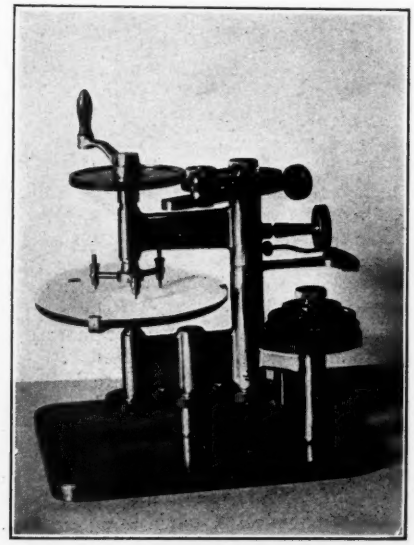
Amperes: Corrected mean value	141.6
Volts: Corrected mean value	102.8
Speed: R.P.M.	939
Output: Amperes × volts = watts	14550
Heating loss in armature C^2R = watts	826
Stray power loss, watts	3275
Total input, watts	18651
Total input, H.-P.	25.0
Loss in belt and shafting, H.-P.	0.6
Output of engine, H.-P.	25.6

The cycloidograph was shown and explained by the inventor, Mr. John F. Cooley. This instrument, of which an illustration is herewith presented, consists of a number of pencils revolving above a plane, the plane itself rotating in the same direction. By shifting the position of the two axes, which can be done by turning the projecting arm which carries the pencils, and by changing the ratio of speed of the pencils and the revolving disc, a great variety of figures can be described. It is evident that if a piece of metal were substituted for the plane, and cutters for the pencils, a hole of almost any shape might be cut in the metal. Again, if cutters were stationed at the proper point on a revolving annulus, rotating at the same speed as the plane, and a piece of metal were substituted for the markers, it would, by adjustment of the apparatus, turn the metal into any form that could be described upon the plane of the cycloidograph. This is the principle which has been applied to machine lathes for turning the complex parts of the cycloidal engine. Two of these lathes were shown in operation.



Rotary Engine Coupled to Dynamo.

An automobile has been equipped with one of these small engines, and it is claimed that this shows a much greater output in power, in comparison with the steam consumption and working space available in this class of service.



Cycloidograph.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW MICHIGAN POWER PLANT—A water-power plant has been projected, utilizing the falls on the Escanaba River, Negaunee, Mich. It is estimated that 100,000 horse-power can easily be obtained. A pulp mill is stated to be the first installation to be erected, and the plans are already practically under way. It is also planned to transmit power to Iron Mountain, Escanaba, Menominee and Marinette, and to furnish power in Negaunee, Ishpeming and Marquette, and for the street railway to be built from Negaunee to Marquette.

LOCAL TROLLEYS TO BE EXTENDED IN NEW YORK STATE—The stockholders of the Utica & Mohawk Valley Railway Company have authorized an increase in the capital stock from $3,100,000 to $6,300,000. This, it is stated, will be for the extension of local trolley lines, which now extend to Rome, on the west, and Little Falls, on the east. The company already has a long line, but is securing franchises and rights of way for further construction, and it is understood that the lines will eventually be converted into a continuous system of railways extending from New York to Syracuse.

INTERURBAN RAILWAY FOR PITTSBURG—Charters have been granted to a syndicate of Pittsburg and New York men for a system of street railways in Pittsburg and Wilkensburg, the proposed lines of which will cover about forty-five miles and cost about $2,000,000. Most of the lines, it is stated, will be built this summer. The charters are as follows: Squirrel Hill & Wilkinsburg Street Railway Company, Pittsburg, to build fifteen miles of road; Iron City Street Railway Company, Pittsburg, to build eight miles of road; Pittsburg Rapid Transit Company, of Pittsburg, to build twelve miles. The incorporators are: Walter F. Render, M. J. McGinn, Frank P. Graffin, Albert G. Calvin and Patrick Cavanaugh. The combined capital of the roads is $255,000.

LARGE JERSEY TROLLEY MERGER RATIFIED—Five large New Jersey corporations have effected a merger, under a new company capitalized at $25,000,000, of all the trolley railway interests in Hudson, Essex, Passaic and Union counties. By this consolidation companies operating 450 miles of track are brought under a single management. The companies absorbed by the action of their several boards of directors are: The North Jersey Street Railway Company, the Jersey City, Hoboken & Paterson Street Railway Company, the Elizabeth, Plainfield & Central Jersey Railroad Company, the Orange & Pacific Valley Railroad Company, and the United Electric Company, of New Jersey. The new corporation, which is to be known as the United New Jersey Railways Company, is planning extensive improvements, and it is understood that some traffic arrangement is contemplated whereby the cars of the company will gain access into Manhattan through one of the prospective Hudson River tunnels.

POWER STATIONS FOR CONNECTICUT ELECTRIC ROADS—With the maturing of the plans for the proposed New Milford Power Company, which is now before the Connecticut Legislature with a charter to build a dam at Kent, on the Housatonic River, to supply electricity for trolley and manufacturing purposes, it is evident that a large development in the electric railroad systems of Connecticut is about to begin. It was originally stated that the New Milford company proposed to lease electricity to the Connecticut Lighting and Railway Company, which operates the Waterbury, Naugatuck, Seymour, Derby, Bridgeport and Norwalk electric roads. It is now stated that the Meriden, Southington & Compounce Road is to share in the new system, and that other roads are to make practically the same arrangement. The Meriden, Southington & Compounce Road will abandon its present electric generating station at Milldale next fall, and lease part of the power engaged by the Connecticut Lighting and Railway Company. At the Kent power-house 6,000 horse-power will be installed at first, which may be increased to 20,000. Of the entire water power on the river, the minimum will be used, owing to the varying supply of water at dry seasons.

TRANSPORTATION PROBLEMS AND PROGRESS IN GERMANY—A consular report from Frank H. Mason, consul-general at Berlin, dated March 13, gives some interesting facts relating to the electric railway situation in Germany. Not only in Berlin, but apparently throughout the empire, the substitution of electric tramways for horse-cars, the institution of trolley lines between neighboring towns and cities, and the improvement of service on lines already in operation, is going on with great vigor. Some of this progress is due to the fulfillment of plans and contracts which were made during the prosperous years preceding the summer of 1901. On the other hand, much of it is purely contemporary—the outgrowth of a progressive ambitious spirit. In Berlin the whole system of intra-mural and suburban transit has been revolutionized within the past five years. The last horse-car has disappeared, being replaced by spacious and comfortable electric tram cars which traverse every part of the city, and lead to a constantly widening circle of populous suburban cities and towns. The elevated and underground electric railway, built by Siemens & Halske, and opened for traffic in February, 1902, has proven a remarkable success. It carries passengers a distance of three miles in ten minutes, for fares ranging from two and one-half to three and three-quarter cents, according to the class of the car. Its traffic and earnings exceeded by eighty per cent the estimates of the builders when the enterprise was planned. There is now an imperative demand for a rapid transit line from north to south, and the municipal highways committee has now under consideration several projects, one of which, proposed by City Engineer Gerlach, contemplates a combined elevated and underground line from Reinickendorf, the extreme northern suburb, southward through the Thiergarten section, and southwestward to the Grunewald, with branches into the central portion of the city. The other scheme is for a suspended electric railway on the Langen system which will traverse the city from north to south in a single loop, so that no reversal of trains at terminal stations will be required. The trains are to be made up wholly of motor cars—one second and two third-class cars in each train, the three capable of seating 150 persons. Including stops, an average speed of twenty-one miles an hour is proposed, with a maximum of thirty miles in the suburban sections. Electric traction on canals is also receiving a great deal of attention in Germany. In deference to the general demand for improvement in canal transportation, the government early last year formulated a plan for the employment of electric traction engines for towing boats on the Teltow Canal, which will connect the Havel with the river Spree, just south of Berlin. The canal is twenty-three miles in length, with one lock, and passes for a short distance through a lake, where tugs, instead of towing engines, will have to be used. Bids were solicited for the electric installation, to comply with certain prescribed conditions, the motors being adapted to towing boats ranging from 175 to 600 tons, loaded to seventy per cent of their capacity, and to be worked with a three-phase current of 8,000 volts and fifty periods. For an estimated annual traffic of 1,500,000 tons, it is proposed to equip one shore of the canal, and the service will require fifty-three locomotives, capable of towing one boat of 600 tons, or two of 200 tons each, besides six tugs to tow the boats across the lake.

OBITUARY NOTICE.

MR. WILLIAM W. CARD, second vice-president of the Westinghouse Air Brake Company, died on April 4 at Pittsburg, Pa., the victim of a trolley-car accident, the injury occurring in front of his own house. Mr. Card entered the Westinghouse Air Brake Company's service in 1872, and became secretary in 1879. He filled this position actively until last year, when he retired with the title of second vice-president. Aside from his connection with the Westinghouse company, Mr. Card became president four years ago of the Pittsburg Screw and Bolt Company. He was particularly well known among railroad men, and was a prominent factor in the early railroad development of the United States.

ELECTRIC RAILWAYS.

HILLSDALE, MICH.—The common council has granted a franchise to Peter P. Ducet for an electric railroad through Hillsdale.

URBANA, OHIO—Work has been commenced on the construction of the track of the Urbana, Bellefontaine & Northern Electric Railway.

MADISONVILLE, KY.—It is stated that Chicago and Louisville capitalists have under consideration the construction of an electric railroad connecting Madisonville and Earlington.

CORRY, PA.—The Mayor has signed the franchise giving James McCabe, of Philadelphia, and the Erie, Cambridge Union & Corry trolley line power to commence operations in this city.

SYRACUSE, N. Y.—The Marcellus Electric Railroad, partly constructed, has been sold on mortgage foreclosure to W. P. Barrows, of Philadelphia, for $75,000. The purchaser states the road will be completed at an early date.

DIXON, ILL.—The Rockford & Freeport Electric Railway Company has filed papers providing for an increase in capital stock from $50,000 to $750,000, and for the right to borrow a sum equal to the capital stock of the corporation.

GREENSBURG, PA.—McKeesport capitalists are reported to be backing a project for the construction of a street railway between Webster and West Newton, a distance of five miles. The cost of the proposed road is estimated at $100,000.

WORCESTER, MASS.—The Hartford & Worcester Street Railway Company has been organized. The corporation is capitalized at $300,000, and will build through Leicester, Charlton, Sturbridge, Brimfield, Wales and Holland, on the route from Worcester to Hartford.

TRENTON, N. J.—The Illinois Railway and Light Company, with an authorized capital of $3,000,000, has been incorporated here. The company is to construct and operate street railways, and to furnish light. Incorporators: Louis P. Dailey, Joseph M. Mitchell, H. O. Coughlin, Warren N. Akers and B. B. Lewis, all of Jersey City.

DE PERE, WIS.—The common council has granted a franchise for an electric railway through the city to the Knox Construction Company. With the completion of this link there will be a continuous interurban line from Fond du Lac to Green Bay, through Oshkosh, Neenah, Menasha, Appleton, Kaukauna, De Pere, and intermediate points.

BOWLING GREEN, OHIO—The directors of the Lake Erie, Bowling Green & Napoleon Electric Railroad have voted to increase the capital stock from $300,000 to $1,000,000, the increase to be used to build the proposed extension from Pemberville to Port Clinton. Most of the rights of way and all of the franchises have been secured, and work will be begun as soon as possible.

COLUMBUS, OHIO—The People's Rapid Transit Railway Company, of Toledo, capitalized at $500,000, has been incorporated by Louis Weadock, M. Albert Merkley, Adam Burger, George Bloodhart and Thomas M. Franey. The company proposes to operate an electric line from Cincinnati to Toledo, extending through the counties of Hamilton, Butler, Preble, Darke, Mercer, Van Wert, Paulding, Defiance, Williams, Henry, Fulton and Lucas.

INDIANAPOLIS, IND.—The Indianapolis, Greencastle & Western Traction Company has been organized to build an electric line from Indianapolis to Terre Haute. The company has a capital stock of $50,000, and was incorporated by Frank M. Fauvre, Charles E. Coffin, M. B. Wilson, Ansel Fatout, Augustus L. Mason, J. W. Chipman and Emil Rassmann. It is understood that arrangements have been completed for the sale of the bonds, and that rights of way have been secured for the greater part of the road.

CUMBERLAND, MD.—A certification of incorporation has been issued to the Westernport & Keyser Traction Company, to build a line from Westernport, the terminus of the Cumberland & Westernport line, to a point near Keyser, W. Va., the line to follow the south bank of the Potomac River. The capital of the company is $20,000, and the incorporators are: Ninian M. Bond, Bond, Md.; James L. Luke, Luke, Md.; David P. Miller, Cumberland, Md.; Zadock T. Kalbaugh, Piedmont, W. Va.; James C. Watson, Keyser, W. Va.

ELECTRIC LIGHTING.

HAMMONTON, N. J.—The Electric Light Company has sold its plant to Philadelphia capitalists.

DIXON, ILL.—The Dixon Power and Lighting Company will increase its capital stock from $100,000 to $200,000.

MIDLAND, ONTARIO—This village has taken over the electric light system, for the sum of $9,600. They will expend $10,000 more in improvements.

DUBUQUE, IOWA—A new power-house will be erected by the Chicago, Milwaukee & St. Paul Company, to replace the present one. The cost will be $20,000.

NEWPORT, KY.—The South Covington & Cincinnati Street Railway Company is erecting a big addition to its power-house. The entire cost will be $60,000.

JASPER, ALA.—Work is being pushed rapidly on the electric light plant which is being constructed by J. M. Cranford. The plant, when complete, will cost over $20,000.

ST. JOSEPH, MO.—The contract for erecting the railway company's new power-house has been let, and the company expects to have same completed and ready for use between August 15 and September 30.

CLINTON, LA.—The town council has granted a thirty-five-year franchise to the Clinton Electric Light and Ice Company, capitalized at $30,000. The plant is expected to be in operation in about sixty days.

ST. AUGUSTINE, FLA.—It is stated that Philadelphia capitalists are seeking to secure a franchise for an electric light plant and trolley system, and that if the same can be secured, all work will be completed within twelve months.

HINTON, W. VA.—A deal has been closed whereby the electric ice and water plants have passed into the hands of O. M. Lance, T. F. Ryman and H. G. Marcy, of Wilkesbarre, Pa. The price paid for the electric light and ice plants was $25,000, and for the water plant $51,000.

ANNAPOLIS, MD.—The Independent Electric Light and Power Company has asked the city council for permission to erect poles and string lines within the city limits. The company is composed of Pittsburg capitalists, and the officers are: Henry A. Smith, president; William Baker, vice-president; Charles A. White, secretary.

COLUMBUS, OHIO—Sealed proposals will be received by the clerk of public works of the city of Columbus, at his office in the City Hall Building, until April 24, at noon, for the construction of the municipal electric light building, according to plans and specifications on file in the office of the director of public improvements.

PORT ARTHUR, ONTARIO—At a recent special meeting of the council an agreement was entered into with the Anglo-American Power Company, through Hunter, Cooper & Company, of Winnipeg, for the supply of 1,000 electrical horse-power, at $15 per horse-power per year. The people back of the company are said to be English capitalists.

SANTA BARBARA, CAL.—It is stated that an electric plant will be erected at Summerland for the purpose of supplying the entire coast from Carpinteria to Santa Barbara. In connection with the enterprise there is also a plan to construct an electric line between these points. The lighting plant will be separate from the railway enterprise, and will be completed first.

PLAINFIELD, CT.—Thomas C. Perkins, of Hartford, is endeavoring to secure from the general assembly a special charter incorporating the Eastern Connecticut Electric Power Company, which will develop water power on the Quinnebaug River in the towns of Plainfield and Canterbury. The company will supply electric power in Windham, Tolland, New London and Middlesex counties. It is estimated that a minimum of 1,800 and a maximum of 2,200 horse-power can be developed. It is stated that another concern, to be known as the Scotland Electric Power Company, is endeavoring to secure a special charter to develop a large water privilege on the Shetucket River in the town of Scotland, and to supply electricity in Scotland, Franklin, Sprague, Lisbon, and other towns in Windham and New London counties.

ELECTRICAL SECURITIES.

Although the week just past has been slightly restricted, owing to the religious holiday, the speculation showed a decided improvement. There was an absence of any heavy liquidation, and the market showed a tendency to rally, notwithstanding the recent persistent declines.

The decision in the Northern Securities case was probably the most important event of the week. This decision, coming on the last business day, did much to depress the otherwise buoyant tendency of the market. This decision will be appealed, and a final verdict from the Supreme Court is looked for during the fall term. The outcome, however, promises to again throw a shadow of apprehension over the financial operations, and while many interests looked forward to an adverse decision to the holding corporation, there was at all times the doubtful hope that some extenuating circumstance might come along with the decision.

ELECTRICAL SECURITIES FOR THE WEEK ENDING APRIL 11.

New York:	*Closing.*
Brooklyn Rapid Transit	66⅞
Consolidated Gas	206
General Electric	185
Kings County Electric	220
Manhattan Elevated	138
Metropolitan Street Railway	133½
New York & New Jersey Telephone	164
Westinghouse Manufacturing Company	211

Boston:	*Closing.*
American Telephone and Telegraph	155½
Edison Electric Illuminating	265
Massachusetts Electric	88½
New England Telephone	136
Western Telephone & Telegraph preferred	97½

Philadelphia:	*Closing*
Electric Company of America	8 15/16
Electric Storage Battery common	77
Electric Storage Battery preferred	75
Philadelphia Electric	6⅞
Union Traction	46¾
United Gas Improvement	106½

Philadelphia Electric stockholders at the annual meeting elected William P. Conover, Jr., a director, in place of John M. Mack, who resigned some time ago. Other directors were reelected.

Chicago:	*Closing.*
Chicago Telephone	150
Chicago Edison Light	155
Metropolitan Elevated preferred	78
National Carbon common	24½
National Carbon preferred	99
Union Traction common	9⅛
Union Traction preferred	37

PERSONAL MENTION.

MR. J. E. MEEK, of the asbestos department of the H. W. Johns-Manville Company, New York city, recently made a trip to Washington and Newport News.

MR. W. B. HALE, electrical engineer in charge of the laboratories of the Western Electric Company, Chicago, Ill., was a visitor to New York city during the past week.

MR. RALPH D. MERSHON, chairman of the Transmission Committee of the American Institute of Electrical Engineers, recently sailed for England. Mr. Mershon will return about the middle of May.

MR. W. E. ANDREWS, formerly associate editor of the *Street Railway Journal*, it is announced, will be in charge of the new department in New York city opened by E. P. Roberts, electrical engineer and contractor, of Cleveland, Ohio.

MR. W. D. SARGENT, vice-president of the New York & New Jersey Telephone Company, who was recently married to Miss Mary F. Kooser, of Somerset, Pa., has returned to Brooklyn from an extended wedding trip in the South.

DR. WALTHER NERNST took an active part in the proceedings of the American Electrochemical Society Convention this week. He agreed to present a paper on "The Determination of Vapor Density in the Electric Furnace," on Saturday evening, April 18, following the presidential address.

MR. C. O. MAILLOUX has reprinted from "The Brown and White" of Lehigh University a complimentary edition of his excellent address on "Some of the Factors Bearing Upon the Success and Career of the Consulting Engineer," delivered before the students of Lehigh University, February 20, 1903.

MR. VICTOR C. GILPIN, recently secretary of the Supply Dealers' Association, and formerly New York agent for the Cutter Electric Manufacturing Company, has returned to New York after a long trip in the interest of the De Veau Telephone Manufacturing Company, with which he recently became connected.

SENOR L. GARCIA, Guayaquil, Ecuador, will make a trip to New York, remaining here for several weeks, in order to receive bids and specifications for the construction of a new system of sewers, fire mains and pumping stations for Guayaquil. Funds for this work have been provided by the imposition of an export duty on cocoa.

MR. ARTHUR C. HOBBLE and MR. F. W. KING arrived at Bangalore, India, on March 10. Since then they have been busy making preparations for a permanent location at Swasamudram, which is the place where the generating station at Cauvery Falls, India, is located. These gentlemen are in charge of the Cauvery Power Scheme, Mysore Province, India.

CAPTAIN E. L. ZALINSKI, United Stated Army, retired, of dynamite-gun fame, was the victim of a severe fire at his rooms in Fifth avenue, New York, last week. The captain was so desirous of remaining and securing a number of valuable models and specimens of his work from the approaching flames that the firemen finally carried him off bodily, the determined soldier putting up a strong resistance. Fortunately the loss was slight.

MR. W. M. ANTHONY, Chicago, Ill., "Reporter on Office Methods and Accounting" for the twenty-sixth convention of the National Electric Light Association, to be held in Chicago, May 26, 27 and 28, has sent out a letter to members asking them for forms, etc., used by them in connection with meters, billing, ledgers, purchases, vouchers, classification of accounts, expenditures, and general information as to any matters relating to this department of their business. From responses received a report is being compiled.

MR. H. J. W. DAM, who was well known in electrical circles of New York during Electric Club days and afterward resided in London for several years, has won renown as a playwright and as a writer on technical and dramatic topics. A new play written by him entitled "Skipper & Co., Wall Street," will be presented at the Garrick Theatre under the capable management of Mr. Frank McKee, one of the best-known theatrical managers in the United States. Mr. Dam's many old-time friends in the electrical field will extend to him a cordial welcome, and his brilliant work in the past assures an unusual treat to all in the audience at the Garrick in New York city, on the opening night, May 4.

NEW INCORPORATIONS.

UNION, W. VA.—Monroe Mutual Telephone Company. $8,000.

COLLINS, MISS.—Collins Light and Power Company. $10,000.

INDIANAPOLIS, IND.—St. Joseph Union Telephone Company. $10,000.

McCRORY, ARK.—M. H. Patterson Telephone Company. $20,000.

MADISON, WIS.—Eagle Telephone Company. Increased to $30,000.

COLUMBUS, OHIO—Carey Electric Telephone Company. Increased to $25,000.

CARTHAGE, MO.—Holt Electric Company. $10,000. Incorporators: Robert Holt, J. E. Long, Hall M. Broggess.

TUPPERS PLAINS, OHIO—The Citizens' Telephone Company. $10,000. Incorporators: C. W. Okkes, L. L. Lowman, F. G. Taylor, S. P. Deem, J. P. Parish, F. C. Chase and George Shields.

INDUSTRIAL ITEMS.

THE AMERICAN MICA COMPANY has moved its general offices from 275 Congress street, Boston, Mass., to its factory at Newton Lower Falls, Mass.

THE NERNST LAMP COMPANY, Pittsburg, Pa., through its Utah agent, the Salt Lake Electric Supply Company, has recently secured the lighting contract for the large department store of the Keith-O'Brien Dry Goods Company, of Salt Lake City.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has published a new telephone price list, dated April, 1903. This price list contains a full line of telephones and telephone parts, and also construction material of every description. Copies will be sent on application.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, will supply on request an interesting leaflet entitled "How to Pack Gas Engine Cylinder Heads," giving full directions for cutting gaskets, preparing the flange, and applying the gasket so that the most efficient service may be obtained.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., in its fan motor bulletin for 1903, describes and illustrates a very complete line of fans and fan motors for desk, bracket and ceiling apparatus. This catalogue also illustrates a line of special wall switch rheostats, ventilating fan outfits, battery fan motors and accessories.

THE SCHAPIROGRAPH COMPANY, 265 Broadway, New York city, manufacturer of the Schapirograph duplicator, claims a number of important features for this apparatus. This device, the maker states, will multi-copy, in all colors, anything written with a pen, up to 150 copies. Descriptive literature will be sent on request.

THE COMPAGNIE INTERNATIONALE D'ELECTRICITE SOCIETE ANONYME, Liège, Belgium, supplied, through its London house, the International Electrical Engineering Company, Surrey street, Strand, London, W. C., the machinery installed at the Erith, Kent, England, power-house, recently described in the ELECTRICAL REVIEW.

THE NEWTON ENGINEERING COMPANY, Milwaukee, Wis., has acquired the electrical and mechanical engineering business of the late A. N. Patitz. The headquarters of the Newton company is at the Hathaway Building, and the company has extended its business to include hydraulic and electric power plants, as well as structural and civil engineering.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, is distributing a folder entitled "Sixteen All-Ways." This describes the "Sterling Special" electric lamp, the chief feature of which is the construction of the coil, which the company claims will distribute a full intensity of light of sixteen candle-power in all directions. This pamphlet will be mailed on request.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, usually shows more than ordinary cleverness in its advertising literature. One of the latest products of this company is a folder illustrating the different points of merit of the Warren alternator, and also giving considerable information with regard to the Warren transformer. On the reverse side of the folder is a long list of satisfied users of this apparatus.

THE STOW MANUFACTURING COMPANY, Binghamton, N. Y., manufacturer of the celebrated Stow multi-speed motor, is applying this system of control to a number of special forms of apparatus. One of the most successful types of machines built by this company is the portable multi-speed motor. This can be used with a flexible shaft for a great variety of services, and the company is meeting with a brisk demand for its machinery.

THE COMMERCIAL ELECTRICAL SUPPLY COMPANY, 1007 Market street, St. Louis, Mo., has a new specialty which is designated as the Commercial inverted cone fixture. This consists of a reflector which utilizes an inverted cone for distributing light rays from a cluster of incandescent lamps. The literature upon the subject will be supplied on request. This company has secured the contract for the automatic police boxes for the World's Fair.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has sold the following apparatus to the New York Edison Company, supplementing the half-million dollar contract reported some months ago: One 1,000-kilowatt "S. K. C." generator, and seven 150-kilowatt booster sets. The Stanley Electric Manufacturing Company has also contracted to furnish three 550-kilowatt "S. K. C." synchronous motors to the Municipal Gas Company, of Albany.

THE COLUMBIA INCANDESCENT LAMP COMPANY, 2115 and 2119 Locust street, St. Louis, Mo., is distributing a novel folder advertising some of the features of the Columbia incandescent lamp. The Columbia company has built a new factory, which has been equipped with the most modern design of machinery and appurtenances for producing large numbers of high-grade incandescent lamps. To this has also been added extra facilities for promptly shipping orders of any magnitude.

THE CONNECTICUT TELEPHONE AND ELECTRIC COMPANY, Meriden, Ct., has been incorporated under the laws of the state of Connecticut, with the following officers: E. C. Wilcox, president; B. L. Lawton, vice-president and treasurer, and B. C. Rogers, secretary. This company has heretofore been carried on as a partnership between E. C. Wilcox and B. L. Lawton. The company has recently built a new improved factory for the manufacture of telephone apparatus. This plant has just been equipped, at heavy expense, with new automatic machinery, and notwithstanding the fact that the business is now greater than ever before, the company is looking forward to a still greater demand for its apparatus.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has added a number of new Exide battery depots to the list hitherto announced. The complete list at present embraces the following stations: New York, No. 148 West Eighteenth street; Philadelphia, 250 North Broad street; Boston, 39 Stanhope street; Buffalo, 200 Pearl street; Chicago, 264 Michigan Boulevard; St. Louis, 3937 Olive street; Rochester, 158 South avenue; Toledo, 715 Jefferson street; Detroit, 265 Jefferson avenue. The increasing use of Exide batteries, and the great convenience of these depots to users of electric vehicles, has encouraged the company to increase these as rapidly as favorable conditions could be secured. New stations will, therefore, be announced from time to time.

THE INCANDESCENT ELECTRIC LIGHT MANIPULATOR COMPANY, 116 Bedford street, Boston, Mass., is marketing a strong list of specialties in incandescent lamp fixtures. Among the more prominent of these are the Morse and Webster adjusters, which regulate the height and angle of the lamp, respectively, allowing the light to be focussed directly on the work. These adjusters have found ready application in a large number of factory and office buildings throughout the country. Another one of the specialties is the lamp manipulator, which is used to replace any bulb of a standard make, or clean the lamp bulb, without removing it from its socket, doing away with long-extension or step-ladders, or staging of any description. Two other popular specialties are the Morse automatic incandescent cord lamp adjuster, and the Webster angle adjuster and reflector combined.

I. P. FRINK, 551 Pearl street, New York city, manufacturer of reflectors and fixtures for decorative lighting, has received the following communication: "Answering your enquiry of the 26th, in regard to the church electric light fixtures bought of you, would say five of the seven churches here are lighted with your fixtures. The Presbyterian church has one large fixture; the Christian church, one large and one small fixture; the First United Presbyterian has two large and two small fixtures; the Methodist, two large and one small fixtures, and the Lutheran, one small fixture. All the different congregations are well pleased with the fixtures. Some time ago a minister was here, who had charge of some mission in India. He was so strongly impressed with the lighting by your fixtures that he came to me for your address, and said he would order some fixtures to be sent to India. C. E. Pierce, purchasing agent, Pawnee City Light and Water Plant, Pawnee, Neb."

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Chicago, Ill., reports a very extensive business, and states that its Chicago factory at the present time is turning out 1,200 telephones a day, and in order to keep up with its orders, it is expected that the factory space will have to be increased to a considerable extent. The company has recently sold telephones and material to the Farmers' Telephone Company, Windsor, Ill.; the Green Valley Telephone Company, Green Valley, Ill., and to the London Mills Telephone Company, London Mills, Ill. Switchboards have been sold to the following companies: Rossville Home Telephone Company, Rossville, Ind.; West Virginia Western Telephone Company, Parkersburg, W. Va.; Winchester Telephone Company, Winchester, Ind.; S. S. Hooks, Gilmore, Ill.; J. W. Corwin, Dahlgren, Ill.; Newport Telephone Company, Newport, Tenn.; E. P. Phillips, Lakenan, Mo.; Zenith City Telephone Company, Duluth, Minn.; C. E. Miller, Woodburn, Mich.